ANSWERS TO PROBLEMS

Chapter 1 Answers

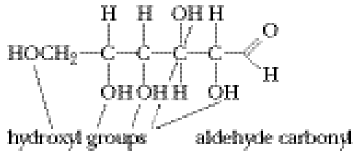
1.1 What Are the Basic Themes for This Text?

1. A polymer is a very large molecule formed by linking smaller units (monomers) together. A protein is a polymer formed by linking amino acids together. A nucleic acid is a polymer formed by linking nucleotides together. Catalysis is the process that increases the rate of chemical reactions compared to the uncatalyzed reaction. Biological catalysts are proteins in almost all cases; the only exceptions are a few types of RNA, which can catalyze some of the reactions of their own metabolism. The genetic code is the means by which the information for the structure and function of all living things is passed from one generation to the next. The sequence of purines and pyrimidines in DNA carries the genetic code (RNA is the coding material in some viruses).

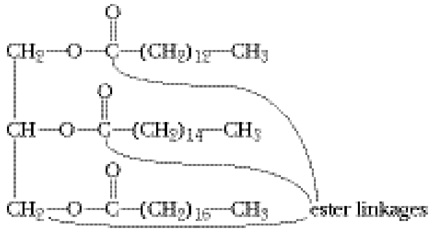
1.2 What Is the Chemical Nature of Important Biomolecules?

2. The correct match of functional groups and compounds containing that functional group is given in the following list.
   Amino group CH3CH2NH2
   Carbonyl group (ketone) CH3COCH3
   Hydroxyl group CH3OH Carboxyl group CH3COOH Carbonyl group (aldehyde)
   CH3CH2CHO Thiol group CH3SH Ester linkage CH3COOCH2CH3
   Double bond CH3CHCHCH3 Amide linkage CH3CON(CH3)2
   Ether CH3CH2OCH2CH3
3. The functional groups in the compounds follow:

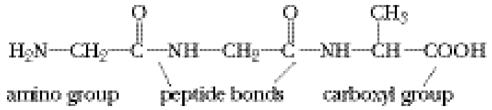
Glucose



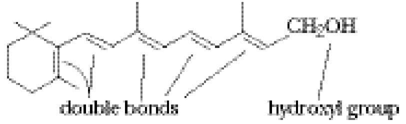
A triglyceride



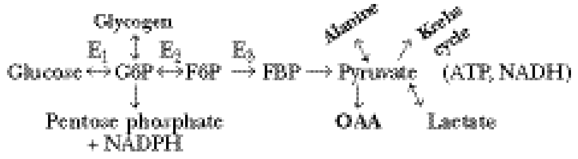
A peptide



Vitamin A



4. Before 1828, the concept of vitalism held that organic compounds could only be made by living systems and were beyond the realm of laboratory investigations. Wohler's synthesis showed that organic compounds, like inorganic ones, did not require a vitalistic explanation, but rather they obeyed the laws of chemistry and physics and thus were subject to laboratory investigation. Subsequently, the concept was extended to the much more complex, but still testable, discipline of biochemistry.
5. Urea, like all organic compounds, has the same molecular structure whether it is produced by a living organism or not.
6.



7. Five; 7 if the two cyclopropane derivatives are allowed.
8. Thirteen different alcohols, 11 aldehydes/ketones, and 10 each epoxides and ethers.

1.3 What Can Biochemistry Say About Possible Origins of Life?

9. It is generally believed that carbon is the likely basis for all life forms, earth-bound or extraterrestrial.
10. Eighteen residues would give 20^{18} or 2.6×10^{23} possibilities. Thus 19 residues would be necessary to have at least Avogadro' s number (6.022×10^{23}) of possibilities.
11. The number is 4^{40} or 1.2 × 1024, which is twice Avogadro's number.
12. RNA is capable of both coding and catalysis.
13. Catalysis allows living organisms to carry out chemical reactions much more efficiently than without catalysts.
14. Two of the most obvious advantages are speed and specificity; they also work at constant temperature or produce little heat.
15. Coding allows for reproduction of cells.
16. With respect to coding, RNA-type polynucleotides have been produced from monomers in the absence of either a preexisting RNA to be copied or an enzyme to catalyze the process. The observation that some existing RNA molecules can catalyze their own processing suggests a role for RNA in catalysis. With this dual role, RNA may have been the original informational macromolecule in the origin of life.
17. It is unlikely that cells could have arisen as bare cytoplasm without a plasma membrane. The presence of the membrane protects cellular components from the environment and prevents them from diffusing away from each other. The molecules within a cell can react more easily if they are closer to each other.

1.4 How Do Prokaryotes and Eukaryotes Differ in Levels of Organization?

18. Five differences between prokaryotes and eukaryotes are: (1) Prokaryotes do not have a well-defined nucleus, but eukaryotes have a nucleus marked off from the rest of the cell by a double membrane. (2) Prokaryotes have only a plasma (cell) membrane; eukaryotes have an extensive internal membrane system. (3) Eukaryotic cells contain membrane-bounded organelles, while prokaryotic cells do not. (4) Eukaryotic cells are normally larger than those of prokaryotes. (5) Prokaryotes are single-celled organisms, while eukaryotes can be multicellular as well as single-celled.
19. Protein synthesis takes place on ribosomes in both prokaryotes and eukaryotes. In eukaryotes, ribosomes may be bound to the endoplasmic reticulum or found free in the cytoplasm; in prokaryotes, ribosomes are only found free in the cytoplasm.

1.5 What Are the Main Structural Features of Prokaryotic Cells?

20. It is unlikely that mitochondria would be found in bacteria. These eukaryotic organelles are enclosed by a double membrane, and bacteria do not have an internal membrane system. The mitochondria found in eukaryotic cells are about the same size as most bacteria.

1.6 What Are the Main Structural Features of Eukaryotic Cells?

21. See Section 1.6 for the functions of the parts of an animal cell, which are shown in Figure 1.10(a).
22. See Section 1.6 for the functions of the parts of a plant cell, which are shown in Figure 1.10(b).
23. In green plants photosynthesis takes place in the membrane system of chloroplasts, which are large membrane-enclosed organelles. In photosynthetic bacteria, there are extensions of the plasma membrane into the interior of the cell called chromatophores, which are the sites of photosynthesis.
24. Nuclei, mitochondria, and chloroplasts are bounded by a double membrane.
25. Nuclei, mitochondria, and chloroplasts all contain DNA. The DNA found in mitochondria and in chloroplasts differs from that in the nucleus.
26. Mitochondria carry out a high percentage of the oxidation energy-releasing reactions of the cell. They are the primary sites of ATP synthesis.
27. The Golgi apparatus is involved in binding carbohydrates to proteins and in exporting substances from the cell. Lysosomes contain hydrolytic enzymes, peroxisomes contain catalase (needed for the metabolism of peroxides), and glyoxysomes contain enzymes needed by plants for the glyoxylate cycle. All these organelles have the appearance of flattened sacs bounded by a single membrane.

1.7 How Do We Classify Organisms: Five Kingdoms or Three Domains?

28. Monera include bacteria (e. g., E. coli) and cyanobacteria. Protista include Euglena, Volvox, Amoeba, and Paramecium. Fungi include molds and mushrooms. Plantae include clubmosses and oak trees. Animalia include spiders, salmon, rattlesnakes, robins, and dogs.
29. The kingdom Monera consists of prokaryotes. The other four kingdoms consist of eukaryotes.
30. The kingdom Monera is divided into the domains Eubacteria and Archaea on the basis of biochemical differences. The domain Eukarya consists of the four kingdoms of eukaryotic organisms.

1.8 Is There Common Ground for All Cells?

31. The major advantage is that of having compartments (organelles) with specialized functions (and thus division of labor). Another advantage is that cells can be much larger without surface area to volume considerations being critical because of compartmentalization.
32. See the discussion of the endosymbiotic theory in Section 1.8.
33. See Exercise 32. The division of labor in cells gives rise to greater efficiency and a larger number of individuals. This in turn allows more opportunity for evolution and speciation.

1.9 How Do Cells Use Energy?

34. Processes that release energy are favored.

1.10 What Is the Connection between Energy and Change?

35. The term "spontaneous" means energetically favored. It does not necessarily mean fast.

1.11 What Is the Criterion for Spontaneity in Biochemical Reactions?

36. The system is the nonpolar solute and water, which become more disordered when a solution is formed; ΔSsys is positive but comparatively small. The ΔSsurr is negative and comparatively large because it is a reflection of the unfavorable enthalpy change for forming the solution (ΔHsys).
37. Processes (a) and (b) are spontaneous, whereas processes (c) and (d) are not. The spontaneous processes represent an increase in disorder (increase in the entropy of the universe) and have a negative ΔG° at constant temperature and pressure, while the opposite is true of the nonspontaneous processes.
38. In all cases, there is an increase in entropy, and the final state has more possible random arrangements than the initial state.
39. Since the equation involves multiplication of ΔS by T, the value of ΔG is temperaturedependent.
40. If one considers entropy to be a measure of dispersion of energy, then at higher temperatures, it is logical that molecules would have more possible arrangements due to increased molecular motion.
41. Assuming the value of D*S* is positive, an increase in temperature will increase the - contribution of the entropy component to the overall energy change.
42. The heat exchange, getting colder, reflects only the enthalpy or ΔH component of the total energy change. The entropy change must be high enough to offset the enthalpy component and add up to an overall -ΔG.
43. Entropy would increase. There are more ways that two molecules, ADP and Pi, can be randomized than a single molecule, ATP.

1.12 What Is the Connection between Thermodynamics and Life?

44. The lowering of entropy needed to give rise to organelles leads to higher entropy in the surroundings, thus increasing the entropy of the universe as a whole
45. Compartmentalization in organelles brings components of reactions into proximity with one another. The energy change of the reaction is not affected, but the availability of components allows in to proceed more readily.
46. DNA would have higher entropy with the strands separated. There are two single strands instead of one double strand, and the single strand have more conformational mobility.
47. See the answer to exercise 43. It is still unlikely that cells could have arisen as bare cytoplasm, but the question of proximity of reactants is more to the point here than the energy change of a given reaction.
48. It would be unlikely that cells of the kind we know would have evolved on a gas giant. The lack of solids and liquids on which aggregates could form would make a large difference.
49. The available materials differ from those that would have been found on earth, and conditions of temperature and pressure are very different.
50. Mars, because of conditions more like those on earth.
51. A number of energetically favorable interactions drive the process of protein folding, ultimately increasing the entropy of the universe.
52. Photosynthesis is endergonic, requiring light energy from the sun. The complete aerobic oxidation of glucose is exergonic and is a source of energy for many organisms, including humans. It would be reasonable to expect the two processes to take place differently in order to provide energy for the endergonic one.

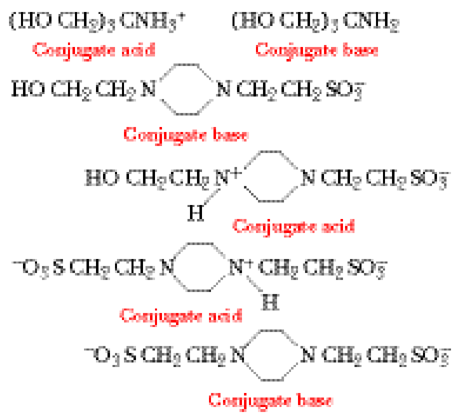
Chapter 2 Answers

2.2 What Is a Hydrogen Bond?

1. Proteins and nucleic acids have hydrogen bonds as an important part of their structures.
2. Replication of DNA and its transcription to RNA requires hydrogen bonding of complementary bases to the DNA template strand.
3. The C—H bond is not sufficiently polar for greatly unequal distribution of electrons at its two ends. Also, there are no unshared pairs of electrons to serve as hydrogen bond acceptors.
4. Many molecules can form hydrogen bonds. Examples might be H_2O, CH_3OH, NH_3.
5. For a bond to be called a hydrogen bond, it must have a hydrogen covalently bonded to O, N, or F. This hydrogen then forms a hydrogen bond with another O, N, or F.
6. In a hydrogen-bonded dimer of acetic acid the —OH portion of the carboxyl group on molecule 1 is hydrogen-bonded to the—C=O portion of the carboxyl group on molecule 2, and vice versa.
7. Glucose = 17 and sorbitol =18, ribitol + 15; each alcohol group can bond to 3 waters and the ring oxygen binds to two. The sugar alcohols bind more than the corresponding sugars.)
8. Hypoventilation decreases the pH of blood. (See BC on p. 54)
9. Aspirin is electrically neutral at the pH of the stomach and can pass the membrane more easily there than in the small intestine.
10. Positively charged ions will bind to nucleic acids as a result of electrostatic attraction to the negatively charged phosphate groups.
11. The unique fitness of water for forming hydrogen bonds determines the properties of many important biomolecules. Water can also act as an acid and a base, giving it great versatility in biochemical reactions.
12. If atoms did not differ in electronegativity, there would be no polar bonds. This would drastically affect all reactions that involve functional groups containing oxygen or nitrogen. That is most of biochemistry.

2.3 What Are Acids and Bases?

13. $(CH_3)_3NH^+$ (conjugate acid)
    (CH3)3N (conjugate base)
    $^+H_3N—CH_2—COOH$ (conjugate acid)
    $^+H_3N—CH_2—COO^-$ (conjugate base)
    $^+H_3N—CH_2—COO^-$ (conjugate acid)
    $H_2N—CH_2—COO^-$ (conjugate base)
    $^-OOC—CH_2—COOH$ (conjugate acid)
    $^-OOC—CH_2—COO^-$ (conjugate base)
    $^-OOC—CH_2—COOH$ (conjugate base)
    $HOOC—CH_2—COOH$ (conjugate acid)
14.



15.
(a) The numerical constant equal to the concentration of the products of the dissociation divided by the concentration of the undissociated acid form: ([H^+][A^-])/[HA]
(b) The qualitative or quantitative description of how much acid (HA) dissociates to hydrogen ion.
(c) The property of a molecule that has both a polar region and an nonpolar region.
(d) The amount of acid or base that can be added to a buffer before experiencing a sharp pH change.
(e) The point in a titration curve where the added acid or base equals the amount of buffer originally present.
(f) The property of a molecule that is readily soluble in water (i.e. water loving)
(g) The property of a molecule that is insoluble in water (i.e. water hating).
(h) The property of a molecule that is not soluble in water. The property of a covalent bond where there is even sharing of electrons and no dipole moments (partial charges).
(i) The property of a molecule that is soluble in water. The property of a covalent bond where the electrons are not shared evenly and dipole moments (partial charges) exist.
(j) An experiment whereby acid or base is added stepwise to a compound and the pH is measured as a function of the added substance.

2.4 What is pH, and What Does It Have To Do with the Properties of Water?

16. The definition of pH is -log[H^+]. Due to the log function, a change in concentration of
10 will lead to a change in pH of 1. The log of 10 is one. The log of 100 is 2, etc.
17. Blood plasma, pH 7.4 [H^+] = 4 0 × 10-8 M
    Orange juice, pH 3.5 [H^+] = 3.2 × 10-4 M
    Human urine, pH 6.2 [H^+] = 6.3 × 10-7 M
    Household ammonia, pH 11.5 [H^+] = 3.2 × 10-12 M
    Gastric juice, pH 1.8 [H^+] = 1.6 × 10-2 M
18.
    Saliva, pH 6.5 [H^+] = 3.2 × 10-7 M
    Intracellular fluid (liver), pH 6.9 [H^+] = 1.6 × 10-7 M
    Tomato juice, pH 4.3 [H^+] = 5.0 × 10-5 M
    Grapefruit juice, pH 3.2 [H^+] = 6.3 × 10-4 M
19.
    Saliva, pH 6.5 [OH^-] = 3.2 × 10-8 M
    Intracellular fluid (liver),pH 6.9 [OH^-] = 7.9 × 10-8 M
    Tomato juice, pH 4.3 [OH^-] = 2.0 × 10-10 M
    Grapefruit juice, pH 3.2 [OH^-] = 1.6 × 10-11 M

2.6 What Are Buffers, and Why Are They Important?

20. The pK of the buffer should be close to the desired buffer pH, and the substance chosen should not interfere with the reaction being studied.
21. The useful pH range of a buffer is one pH unit above and below its p*K*a.
22. Use the Henderson-Hasselbalch equation
    pH = p*K* a$^+$ log ([CH_3COO^-])
    ([CH_3COOH])
    5.00 = 4.76 + log ([CH_3COO^-])
    ([CH_3COOH])
    0.24 = log ([CH_3COO^-])
    ([CH_3COOH])
    [CH_3COO^-] = inverse log of 0.24 = 1.7
    [CH_3COOH] 1
23. Use the Henderson-Hasselbalch equation
    pH = p*K* a$^+$ log ([CH_3COO^-])
    ([CH_3COOH])
    4.00 = 4.76 + log ([CH_3COO^-])
    ([CH_3COOH])
    -0.76 = log ([CH_3COO^-])
    ([CH_3COOH])
    [CH_3COO^-] = inverse log of -0.76 = 0.17
    [CH_3COOH] 1
24. Use the Henderson-Hasselbalch equation
    pH = p*K* a$^+$ log ([TRIS])
    ([TRIS-H^+])
    8.7 = 8.3 + log ([TRIS])
    ([TRIS-H^+])
    0.4 = log ([TRIS])
    ([TRIS-H^+])
    [TRIS] = inverse log of 0.4 = 2.5
    [TRIS-H^+] 1
25. Use the Henderson-Hasselbalch equation
    pH = p*K* a$^+$ log ([HEPES])
    ([HEPES-H^+])
    7.9 = 7.55 + log ([HEPES])
    ([HEPES-H^+])
    0.35 = log ([HEPES])
    ([HEPES-H^+])
    [HEPES] = inverse log of 0.35 = 2.2
    [HEPES-H^+] 1
26. At pH 7.5, the ratio of [HPO_4^{2-}]/[H2PO_{4-}] is 2/1 (p*K*a of H_2PO_{4-} = 7.2), as calculated using the Henderson-Hasselbalch equation. K_2HPO_4 is a source of the base form, and HC1 must be added to convert one-third of it to the acid form, according to the 2/1 base/acid ratio. Weigh out 8.7 grams of K_2HPO_4 (0.05 moles, based on a formula weight of 174 grams/mole), dissolve in a small quality of distilled water, add 16.7 mL of 1 M HC1 (gives 1/3 of 0.05 moles of hydrogen ion, which converts 1/3 of the 0.05 moles of HPO_4^{2-} to H_2PO_{4-}) and dilute the resulting mixture to one liter.
27. A 2/1 ratio of the base form to acid form is still needed, because the pH of the buffer is the same in both problems. NaH_2PO_4 is a source of the acid form, and NaOH must be added to convert two thirds of it to the base form. Weigh out 6.0 grams of NaH_2PO_4 (0.05 moles, based on a formula weight of 120 grams/mole), dissolve in a small quantity of distilled water, add 33.3 mL of 1 M NaOH (gives 2/3 of 0.05 moles of hydroxide ion, which converts 2/3 of the 0.05 moles of H_2PO_{4-} to HPO_4^{2-}) and dilute the resulting mixture to one liter.
28. After mixing the buffer solution (100 mL) contains 0.75 M lactic acid and 0.25 M sodium lactate. The p*K*a of lactic acid is 3.86. Use the Henderson-Hasselbalch equation
    pH = p*K* a$^+$ log ([$CH_3CHOHCOO^-$])
    ([CH3CHOHCOOH])
    pH = 3.86 + log ([$CH_3CHOHCOO^-$])
    ([$CH_3CHOHCOOH$])
    pH = 3.86 + log (0.25 M/0.75 M)

$pH = 3.86 + (-0.48)$

$pH = 3.38$

29. After mixing the buffer solution (100 mL) contains 0.25 M lactic acid and 0.75 M sodium lactate. The p*K*a of lactic acid is 3.86. Use the Henderson-Hasselbalch equation

$pH = pK\,a^{+} \log ([CH_3CHOHCOO^-])$
$([CH_3CHOHCOOH])$
$pH = 3.86 + \log ([CH_3CHOHCOO^-])$
$([CH_3CHOHCOOH])$
$pH = 3.86 + \log (0.75\ M/0.25\ M)$
$pH = 3.86 + (0.48)$
$pH = 4.34$

30. Use the Henderson-Hasselbalch equation

$pH = pK\,a^{+} \log ([CH_3COO^-])$
$([CH_3COOH])$
$pH = 4.76 + \log ([CH_3COO^-])$
$([CH_3COOH])$
$pH = 4.76 + \log (0.25\ M)$
$(0.10\ M)$
$pH = 4.76 + 0.40$
$pH = 5.16$

31. Yes, it is correct, calculate the molar amounts of the two forms and insert into the Henderson-Hasselbalch equation. 2.02 g = 0.0167 mol and 5.25 g = 0.0333 mol)
32. The solution is a buffer because it contains equal concentrations of TRIS in the acid and free amine forms. When the two solutions are mixed, the concentrations of the resulting solution (in the absence of reaction) are 0.05 M HCl and 0.1 M TRIS because of dilution. The HCl reacts with half the TRIS present, giving 0.05 M TRIS (protonated form) and 0.05 M TRIS (free amine form).
33. Any buffer that has equal concentrations of the acid and basic forms will have a pH equal to its p*K*a. Therefore the buffer from exercise 32 will have a pH of 8.3.
34. First calculate the moles of buffer that you have: 100 mL = 0.1 liters, and 0.1 liters of 0.1 M TRIS buffer is 0.01 moles. Since the buffer is at its p*K*a, there are equal concentrations of the acid and basic form, so the amount of TRIS is 0.005 moles, and the amount of TRIS-H^+ is 0.005 moles.

If you then add 3 mL of 1 M HCl, you will be adding 0.003 moles of H^+. This will react as shown:

TRIS + H^+ → TRIS-H^+ until you run out of something, which will be the H^+ since

it is the limiting reagent. The new amounts can be calculated as shown below:

TRIS-H^+ = 0.005 moles + 0.003 moles = 0.008 moles
TRIS = 0.005 moles - 0.003 moles = 0.002 moles

Now plug these values into the Henderson-Hasselbalch equation:

$pH = 8.3 + \log ([TRIS]/[TRIS\text{-}H^+]) = 8.3 + \log(0.002/0.008)$ pH = 7.70

35. First calculate the moles of buffer that you have: (we are going to do some rounding off) 100 mL = 0.1 liters, and 0.1 liters of 0.1 M TRIS buffer is 0.01 moles. Since the buffer is at pH 7.70, we saw in exercise 25 that the amount of TRIS is 0.002 moles, and the amount of TRIS-H^+ is 0.008 moles.

If you then add 3 mL of 1 M HCl, you will be adding 0.003 moles of H^+. This will react as shown:

TRIS + H^+ → TRIS-H^+ until you run out of something, which will be the TRIS

since it is the limiting reagent. All the TRIS is converted to TRIS-H^+:

TRIS-H^+ = 0.01 moles
TRIS = ~0 moles

We have used up the buffer capacity of the TRIS. We now have 0.003 moles of H^+ in approximately 0.1 liters of solution. This is approximately 0.3M H^+.

$pH = - \log 0.3$
$pH = 0.52$

36. [H+] = [A-] for pure acid, thus Ka =$[H+]^2$/[HA]

$[H+]^2$ = Ka x [HA] -2 log [H+] = p*K*a - log [HA]

pH = 1/2 {p*K*a - log [HA]}

37. Use the Henderson-Hasselbalch equation. [Acetate ion]/[acetic acid] = 2.3/1
38. A substance with a p*K*a of 3.9 has a buffer range of 2.9 to 4.9. It will not buffer effectively at pH 7.5.
39. Use the Henderson-Hasselbalch equation. The ratio of A^-/HA would be 3981 to 1.
40. In all cases the suitable buffer range covers a pH range of p*K*a +/− 1 pH units.

Lactic acid (p*K*a = 3.86) and its sodium salt, pH 2.86-4.86
Acetic acid (p*K*a = 4.76) and its sodium salt, pH 3.76-5.76
TRIS (see Table 3.4, p*K*a, = 8.3) in its protonated form and its free amine form,
pH 7.3-9.3
HEPES (see Table 3.4, p*K*a, = 7.55) in its zwitterionic and its anionic form, pH 6.55-8.55

41. Several of the buffers would be suitable, namely TES, HEPES, MOPS, and PIPES, however the best buffer would be MOPS as its p*K*a of 7.2 is closest to the desired pH of 7.3.
42. The solution is called 0.0500 molar, even though the concentration of neither the free base nor the conjugate acid is 0.0500 M. Why is 0.0500M the correct concentration to report? Buffer concentrations are typically reported to be the sum of the two ionic forms.)
43. At the equivalence point of the titration a small amount of acetic acid remains because of the equilibrium $CH_3COOH \rightarrow H^+ + CH_3COO^-$. There is a small, but nonzero, amount of acetic acid left.
44. Buffering capacity is based upon the amounts of the acid and base forms present in the buffer solution. A solution with a high buffering capacity can react with large amount of added acid or base without drastic changes in pH. A solution with a low buffering capacity can react with only comparatively small amounts of acid or base before showing changes in pH. The more concentrated the buffer, the higher is its buffering capacity. The first buffer listed here has 10 times less buffering capacity than the second, which in turn has 10 times less buffering capacity than the third. All three buffers have the same pH, since they all have the same relative amounts of the acid and base form.
45. It would be more effective to start with the HEPES base. You want a buffer at a pH above the p*K*a, which means that the base from will predominate when you have finished preparing it. It is easier to convert some of the base form to the acid form than most of the acid form to the base form.
46. In a buffer with the pH above the p*K*a, the base form predominates. This would be useful as a buffer for a reaction that produces H^+ because there will be plenty of the base form to react with the hydrogen ion produced.
47. Zwitterions tend not to interfere with biochemical reactions.
48. It is useful to have a buffer that will maintain a stable pH even if assay conditions change. Dilution is one such possible change.
49. It is useful to have a buffer that will maintain a stable pH even if assay conditions change. Temperature variation is one such possible change.
50. The only zwitterion is $^+H_3N{-}CH_2{-}COO^-$.

Chapter 3 Answers

3.1 What Are Amino Acids, and What is Their Three-Dimensional Structure?

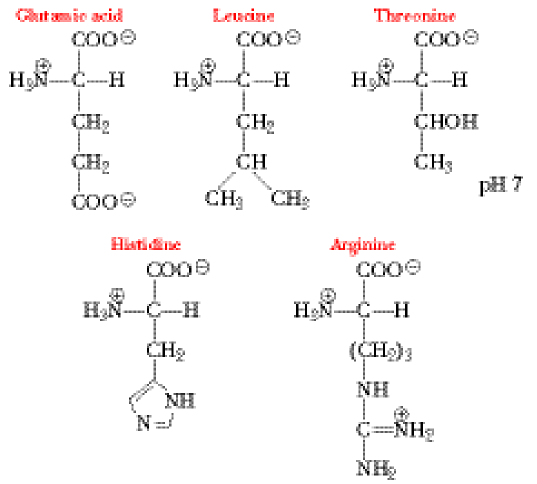
1. D- and L-amino acids have different stereochemistry around the a-carbon. Peptides that contain D-amino acids are found in bacterial cell walls and in some antibiotics.

3.2 What Are the Structures and Properties of the Individual Amino Acids?

2. Proline is technically not an amino acid. Glycine contains no chiral carbon atoms.
3. An amino acid in which the R group contains the following: a hydroxyl group (serine, threonine, tyrosine) a sulfur atom (cysteine, methionine) a second chiral carbon atom (isoleucine, threonine) an amino group (lysine) an amide group (asparagine, glutamine) an acid group (aspartate, glutamate) an aromatic ring (phenylalanine, tyrosine, tryptophan) a branched side chain (leucine, valine)
4. In the peptide, Val-Met-Ser-Ile-Phe-Arg-Cys-Tyr-Leu, the polar amino acids are Ser, Arg, Cys, and Tyr; the aromatic amino acids are Phe and Tyr; and the sulfur-containing amino acids are Met and Cys.
5. In the peptide, Glu-Thr-Val-Asp-Ile-Ser-Ala, the nonpolar amino acids are Val, Ile, and Ala; the acidic amino acids are Glu and Asp.
6. Amino acids other than the usual 20 are produced by modification of one of the common amino acids. See Figure 3.5 for the structures of some modified amino acids. Hydroxyproline and hydroxylysine are found in collagen; thyroxine is found in thyroglobulin.
7. Tyrosine, tryptophan, and their derivatives.
8. A monoamine oxidase is an enzyme that degrades compounds with an amino group, including neurotransmitters; consequently, they can control a person' s mental state.
9. The high concentration of tryptophan in milk protein may mildly elevate the levels of serotonin, which relaxes the brain.
10. The tryptophan in milk might make you sleepy, whereas the tyramine in cheese should pep you up.
11. The amino acids thyroxine and hydroxyproline occur in very few proteins. The genetic code does not include them, so they are produced by modification of tyrosine and proline, respectively.

3.3 Do Amino Acids Have Specific Acid-Base Properties?

12.



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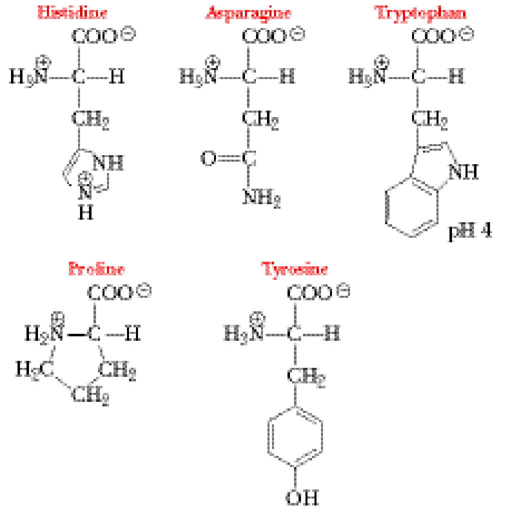
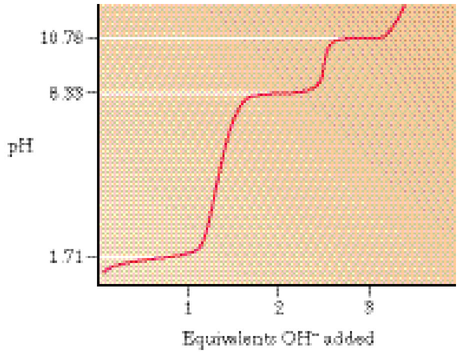
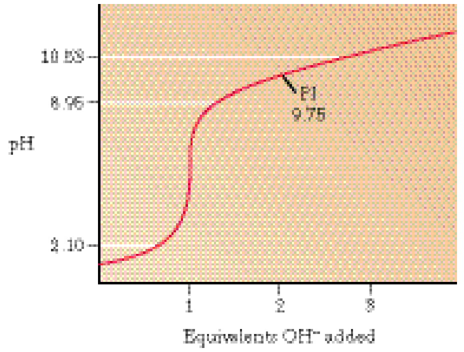


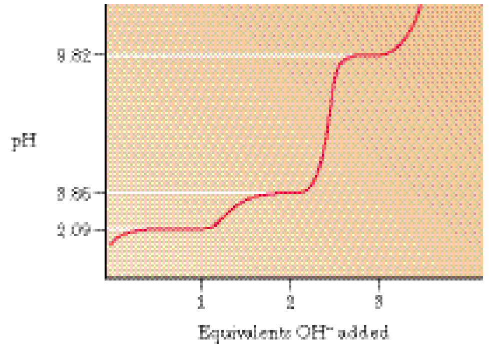
14. Histidine: imidazole is deprotonated, -amino group is predominantly deprotonated. Asparagine: -amino group is deprotonated. Tryptophan: -amino group is predominantly deprotonated. Proline: -amino group is partially deprotonated. Tyrosine: -amino group is predominantly deprotonated, phenolic hydroxyl is approximately a 50 - 50 mixture of protonated and deprotonated forms.
15. Isoelectric point for glutamic acid, 3.25; serine, 5.7; histidine, 7.58; lysine, 9.75; tyrosine, 5.65; arginine, 10.75.
16. Cysteine will have no net charge at pH 5.02 = (1.71 + 8.33)/2 (see titration curve below).



17.

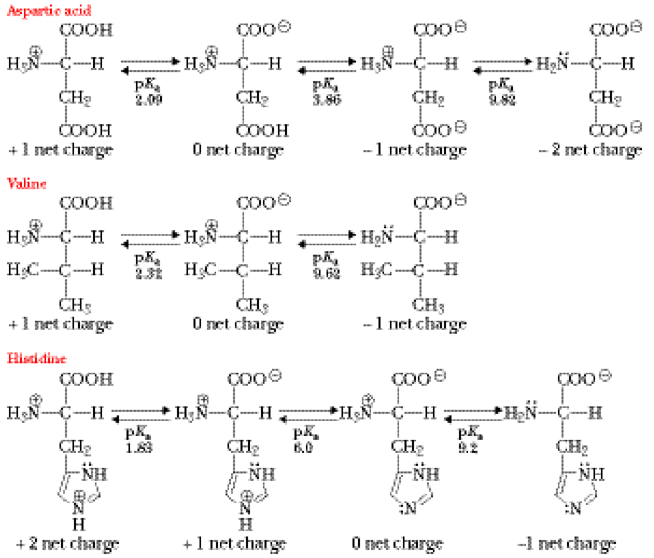


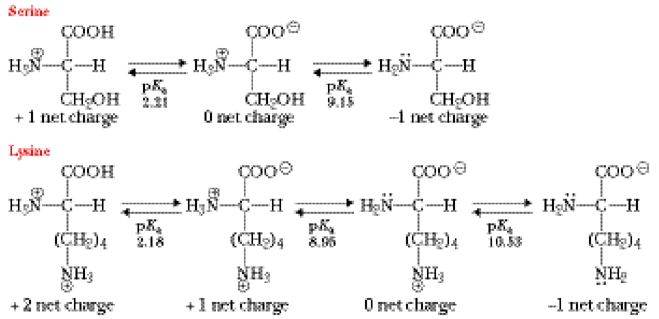
18. The conjugate acid - base pair will act as a buffer in the pH range 1.09 - 3.09.



19. They have a net charge at pH extremes, and the molecules tend to repel each other. When the molecular charge is zero, the amino acids can aggregate more easily.

20. The ionic dissociation reactions of the following amino acids: aspartic acid, valine, histidine, serine, and lysine:





21. The *p*Ka for the ionization of the thiol group of cysteine is 8.33, so this amino acid could serve as a buffer in the -SH and -S- forms over the pH range 7.33-9.33. The - amino groups of asparagine and lysine have *p*Ka values of 8.80 and 8.95, respectively; these are also possible buffers, but they are both near the end of their buffer ranges.

22. At pH 4, the -carboxyl group is deprotonated to a carboxylate, the side chain carboxyl is still more than 50% protonated, and both amino groups are protonated. At pH 7, both the -carboxyl group and the side chain carboxyl group are deprotonated to a carboxylate, and both amino groups are protonated. At pH 10, both the -carboxyl group and the side chain carboxyl group are deprotonated to a carboxylate, one of the amino groups is primarily deprotonated, and the other amino group is a mixture of the protonated and deprotonated forms.

23. The pI refers to the form in which both carboxyl groups are deprotonated and both amino groups protonated at pH 6.96.

23. The pI refers to the form in which both carboxyl groups are deprotonated and both amino groups protonated at pH 6.96.

24. At pH 1 the charged groups are the N-terminal NH_3^+ on valine and the protonated guanidino group on arginine, giving zero net charge. The charged groups at pH 7 are the same as pH 1 with the addition of the carboxylate group on the C-terminal leucine, giving a net charge of -1.

25. Both peptides, Phe-Glu-Ser-Met and Val-Trp-Cys-Leu, have a charge of -1 at pH 1 because of the protonated N-terminal amino group. At pH 7, the peptide on the right has no net charge because of the protonated N-terminal amino group and the ionized Cterminal carboxylate negative charge. The peptide on the left has a net charge of -1 at pH 7 because of the side-chain carboxylate group on the glutamate in addition to the charges on the N-terminal and C-terminal groups.

26. (a) Lysine because of the side chain amino group; (b) Serine because of the lack of a side chain carboxyl; (c) Histidine, because of the presence of a titratable group in the side chain; (d) Aspartate because of the carboxyl group in the side chain.

27. Glycine is frequently used as the basis of a buffer in the acid range near the pK of its carboxyl group. The useful buffer range is from pH 1.3 to 3.3.

3.4 What Is the Peptide Bond?

28. See Figure 3.9.

29. The resonance structures contribute to the planar arrangement by giving the C-N bond partial double bond character.

30. In all cases, the yield is 0.95n. For 10 residues, that means 60% yield; for 50 residues, 8%; and for 100 residues, 0.6%. These are not satisfactory yields. Enzyme specificity gets around the problem.

31. The two peptides differ in amino acid sequence but not in composition.

32. The titration curves of the two peptides will have the same general shape. The *p*Ka values of the -amino and - carboxyl groups will differ. Very careful work will show slight differences in side chain *p*Ka values because of the different distances to the charged groups at the ends of the peptide. Such changes are particularly marked in proteins.

33. Asp-Leu-Phe Leu-Asp-Phe Phe-Asp-Leu Asp-Phe-Leu Leu-Phe-Asp Phe-Leu-Asp

34. DLF LDF FDL DFL LFD FLD

35. You would get 20^{100} ~1.27 × 10^{130} molecules, which is about 10^{84} Earth volumes. The same calculation for a pentapeptide gives more comprehensible results.

36. They are relatively stable because they are zwitterions. They typically have high melting points.

37. With very little doubt, no. Compare predicting the properties of water from those of hydrogen and oxygen, in either atomic or molecular form. If you knew the properties of the protein, you might be able to do the reverse to some extent.

38. These two peptides differ chemically. The open chain has a free C-terminal and Nterminal, but the cyclic peptide has only peptide bonds.

39. Both the C-terminal and the N-terminals of the open-chain peptide can be charged at appropriate pH values, which is not the case with the cyclic peptide. This can provide a basis for separation by electrophoresis.

40. Carbohydrates are not a source of the nitrogen needed for biosynthesis of amino acids.

41. Suggest that your friend show the carboxyl group as a charged carboxylate (-COO^-) and the amino group in its charged form (-NH_3^+).

42. There are very few side chains that have functional groups to form crosslinks.

43. There will be many more possible conformations because of free rotation around the peptide bond.

44. There would be no possibility of disulfide crosslinks within or between peptide chains, giving more possible conformations. There would not be the possibility of oxidation - reduction reactions involving sulfhydryl and disulfide groups.

45. The big difference would be the loss of stereospecificity in the conformation of any peptide or protein. This would have drastic consequences for the kinds of reactions of the protein.

3.5 Are Small Peptides Physiologically Active?

46. Oxytocin has an isoleucine at position 3 and a leucine at position 8; it stimulates smooth muscle contraction in the uterus during labor and in the mammary glands during lactation. Vasopressin has a phenylalanine at position 3 and an arginine at position 8; it stimulates resorption of water by the kidneys, thus raising blood pressure.

47. The reduced form of glutathione consists of three amino acids with a sulfhydryl group; the oxidized form consists of six amino acids and can be considered the result of linking two molecules of reduced glutathione by a disulfide bridge.

48. Enkephalins are pentapeptides (Y-G-G-F-L, leucine enkephalin, and Y-G-G-F-M, methionine enkephalin), which are naturally occurring analgesics.

49. In most cases, D-amino acids are toxic. They occur in nature in antibiotics and bacterial cell walls.

50. The different stereochemistry of the two peptides leads to different binding with taste receptors and to the sweet taste for one and the bitter taste for the other.

Chapter 4 Answers

4.1 How Does the Structure of Proteins Determine Their Function?

1. (a)(2); (b)(4); (c)(l); (d)(3).

2. When a protein is denatured, the interactions that determine secondary, tertiary, and any quaternary structures are overcome by the presence of the denaturing agent. Only the primary structure remains intact.

3. The random portions of a protein do not contain structural motifs that are repeated within the protein, such as a-helix or b-pleated sheet, but three-dimensional features of these parts of the protein are repeated from one molecule to another. Thus, the term "random" is somewhat of a misnomer.

4.2 What Is the Primary Structure of Proteins?

4. When a protein is covalently modified, its primary structure is changed. The primary structure determines the final three-dimensional structure of the protein. The modification disrupts the folding process.

5. (a) Serine has a small side chain that can fit in any relatively polar environment. (b) Tryptophan has the largest side chain of any of the common amino acids, and it tends to require a nonpolar environment. (c) Lysine and arginine are both basic amino acids; exchanging one for the other would not affect the side chain pKa, in a significant way. Similar reasoning applies to the substitution of a nonpolar isoleucine for a nonpolar leucine.

6. Glycine is frequently a conserved residue because its side chain is so small as to fit in spaces that will not accommodate larger ones.

7. When alanine is replaced by isoleucine, there is not enough room in the native conformation for the larger side chain of the isoleucine. Consequently, there is a great enough change in the conformation of the protein that it loses activity. When glycine is substituted in turn for isoleucine, the presence of the smaller side chain leads to resumption of the active conformation.

8. Meat consists largely of animal proteins and fat. The temperatures

involved in cooking meat are usually more than enough to denature the protein part of the meat.

9. Prion diseases have been linked to the immune system. It is believed that the prion proteins travel in the lymph system bound to lymphocytes and eventually arrive at the nervous tissue where they begin to transform the normal prion protein into the abnormal one.
10. While there are strong genetic predispositions to acquire scrapie, that alone will not cause the disease. The disease must be started by ingesting a prion that already has the altered conformation, PrPsc.
11. The protein efficiency ratio is an arbitrary measurement of the essential amino acid content of a given type of protein.
12. Eggs have the highest PER.
13. The amino acids that must be consumed in the diet because the body cannot synthesize them in sufficient quantities.
14. Reasons for creating genetically modified foods include increasing their protein content, increasing their shelf life, increasing their resistance to insects or other pests, and decreasing the need for pesticides to grow them.

4.3 What Is the Secondary Structure of Proteins?

15. Shape, solubility, and type of biological function (static, structural versus dynamic, catalytic).
16. The angles of the amide planes as they rotate about the a-carbon. The angles are both defined as zero when the two planes would be overlapping such that the carbonyl group of one contacts the N-H of the other.
17. A β-bulge is a common nonrepetitive irregularity found in antiparallel β-sheets. A misalignment occurs between strands of the β-sheet causing one side to bow outward.
18. A reverse turn is a region of a polypeptide where the direction changes by about 180°. There are two kinds—those that contain proline and those that do not. See Figure 4.6 for examples.
19. The ahelix is not fully extended, and its hydrogen bonds are parallel to the protein fiber. The β-pleated sheet structure is almost fully extended, and its hydrogen bonds are perpendicular to the protein fiber.
20. The aaunit, the bab-unit, the b-meander, the Greek key, the β-barrel.
21. The geometry of the proline residue is such that it does not fit into the a-helix, but it does fit exactly for a reverse turn. See Figure 4.10(c).
22. Glycine is the only residue small enough to fit at crucial points in the collagen triple helix.
23. The principal component of wool is the protein keratin, which is a classic example of α-helical structure. The principal component of silk is the protein fibroin, which is a classic example of β-pleated sheet structure. The statement is somewhat of an oversimplification, but it is fundamentally valid.
24. Wool, which consists largely of the protein keratin, shrinks because of its α-helical conformation. It can stretch and then shrink. Silk consists largely of the protein fibroin, which has the fully extended β-sheet conformation, with far less tendency to stretch or shrink.

4.4 What Can We Say About the Thermodynamics of Protein Folding?

25. (1) Backbone H-bonds, involving the CO and NH groups of the peptide chain; (2) side chain H-bonds, involving any possible hydrogen bond donor or acceptors on the side chains; (3) hydrophobic interactions, involving the nonpolar groups on the protein; (4) electrostatic interactions, involving any charged groups on the protein; (5) metal ligation, involving coordination bonds between side chains and a metal ion.
26. Stabilization of any conformation depends on lowering of energy, regardless of the kind of interaction involved. With small molecule interactions, the main component of energy changes is enthalpic, with relatively small entropy changes. In the case of molecules as large as proteins, the number of possible conformations makes the entropic part of energy changes much more important. This is particularly true in the case of hydrophobic interactions.

4.5 What Is the Tertiary Structure of Proteins?

27. See Figure 4.2 for a hydrogen bond that is part of the α helix (secondary structure). See Figure 4.13 for a hydrogen bond that is part of tertiary structure (side chain hydrogen bonding).
28. See Figure 4.13 for electrostatic interactions, such as might be seen between the side chains of lysine and aspartate.
29. See Figure 4.13 for an example of a disulfide bond.
30. See Figure 4.13 for an example of hydrophobic bonds.
31. A chaperone is a protein that aids another protein in folding correctly and keeps it from associating with other proteins before it has reached its final, mature form.
32. Configuration refers to the position of groups due to covalent bonding. Examples include *cis* and *trans* isomers and optical isomers. Conformation refers to the positioning of groups in space due to rotation around single bonds. An example is the difference between the eclipsed and staggered conformations of ethane.
33. Five possible features limit possible protein configurations and conformations. (1) Although any one of 20 amino acids is possible at each position, only one is used, as dictated by the gene that codes for that protein. (2) Either a D- or an L-amino acid could be used at each position (except for glycine), but only L-amino acids are used. (3) The peptide group is planar so that only *cis* and *trans* arrangements are observed. The *trans* form is more stable and is the one usually found in proteins. (4) The angles ϕ and ψ can theoretically take on any value from 0° to 360°, but some angles are not possible because of steric hindrance; angles that are sterically allowed may not have stabilizing interactions, such as those in the α-helix. (5) The primary structure determines an optimum tertiary structure, according to the "second half of the genetic code."
34. Technically, collagen has quaternary structure because it has multiple polypeptide chains. However, most discussions of quaternary structure involve subunits of globular proteins, not fibrous ones like collagen. Many scientists consider the collagen triple helix to be an example of a secondary structure.

4.6 Can We Predict Folding from Sequence?

35. This level of sequence homology is marginal for use of comparative modeling. It is best to try that method, but then to compare the results with those obtained from the fold recognition approach.
36. See the Protein Data Bank.
37. A prion is a potentially infectious protein found in multiple forms in mammals, often concentrated in nervous tissue. There is a normal form and an abnormal form that tends to form plaques destroying the nervous tissue. They have been found to be transmissible across species.
38. A series of encephalopathies have been found to be caused by the abnormal prion protein. In cows, the disease caused by prions is called bovine spongiform encephalopathy or more commonly mad cow disease. In sheep the disease is called scrapie. In humans it is called Jakob-Creutzfeld disease.
39. The normal form of the prion protein has a higher α-helix content compared to bsheet. The abnormal one has an increased β-sheet content.

4.7 What Is the Quaternary Structure of Proteins?

40. Similarities—both contain heme group; both are oxygen binding; secondary structure is primarily -helix. Differences—hemoglobin is a tetramer, while myoglobin is a monomer; oxygen binding to hemoglobin is cooperative, but noncooperative to myoglobin.
41. The crucial residues are histidines in both proteins.
42. Myoglobin' s highest level of organization is tertiary. Hemoglobin' s is quaternary.
43. The function of hemoglobin is oxygen transport; its sigmoidal binding curve reflects the fact that it can bind easily to oxygen at comparatively high pressures and release oxygen at lower pressures. The function of myoglobin is oxygen storage; as a result, it is easily saturated with oxygen at low pressures, as shown by its hyperbolic binding curve.
44. In the presence of H^+ and CO_2, both of which bind to hemoglobin, the oxygenbinding capacity of hemoglobin decreases.
45. In the absence of 2,3-*bis*phosphoglycerate, the binding of oxygen by hemoglobin resembles that of myoglobin, characterized by lack of cooperativity. 2,3- *Bis*phosphoglycerate binds at the center of the hemoglobin molecule, increases cooperativity, stabilizes the deoxy conformation of hemoglobin, and modulates the binding of oxygen so that it can easily be released in the capillaries.
46. Fetal hemoglobin binds oxygen more strongly than adult hemoglobin. See Figure 4.25.
47. Histidine 143 in a β-chain is replaced by a serine in a γ-chain.
48. Deoxygenated hemoglobin is a weaker acid (has a higher p*K*a) than oxygenated hemoglobin. In other words, deoxygenated hemoglobin binds more strongly to H^+ than does oxygenated hemoglobin. The binding of H^+ (and of CO_2) to hemoglobin favors the change in quaternary structure to the deoxygenated form of hemoglobin.
49. The primary flaw in your friend' s reasoning is a reversal of the definition of pH, which is $pH = -\log [H^+]$. If the release or binding of hydrogen ion by hemoglobin were the primary factor in the Bohr effect, the pH changes would be the opposite of those actually observed. The response of hemoglobin to changes in pH is the central point. When the pH increases, the hydrogen ion concentration decreases, and vice versa.
50. The change of a histidine to a serine in the γ-chain removes a positively charged amino acid that could have interacted with BPG. Thus there are fewer salt bridges to break, so binding is easier than it is in a β-chain.
51. Persons with sickle-cell trait have some abnormal hemoglobin. At high altitudes, there is less oxygen, and the concentration of the deoxy form of the abnormal hemoglobin increases. Less oxygen can be bound, causing the observed breathing difficulties.
52. In fetal hemoglobin, the subunit composition is $\alpha_2\gamma_2$ with replacement of the β-chains by the γ-chains. The sickle-cell mutation affects the β-chain, so the fetus homozygous for HbS has normal fetal hemoglobin.
53. The relative oxygen affinities allow oxygen to be taken by the fetal cells from the maternal Hb.
54. Because people with sickle-cell disease are chronically anemic, some cells with fetal Hb are produced to help overcome the impaired oxygen delivery system.
55. The crystalline form changed because oxygen entered under the cover slip, transforming deoxyhemoglobin to oxyhemoglobin.

Chapter 5 Answers

5.1 How Do We Extract Pure Proteins from Cells?

1. Blender, Potter-Elvejhem, sonicator
2. If you needed to maintain the structural integrity of the subcellular organelles, a Potter- Elvejhem would be better because it is more gentle. The tissue, such as liver, must be soft enough to use with this device.
3. Salting out is a process whereby a highly ionic salt is used to reduce the solubility of a protein until it comes out of solution and can be centrifuged. The salt forms ion · dipole bonds with the water in the solution, which leaves less water available to hydrate the protein. Nonpolar side chains begin to interact between protein molecules, and they become insoluble.
4. Their amino acid content and arrangements make some proteins more soluble than others. A protein with more highly polar amino acids on the surface will be more soluble than one with more hydrophobic ones on the surface.
5. Homogenize the liver cells using a Potter-Elvejhem homogenizer. Spin the homogenate at 500 X g to sediment the unbroken cells and nuclei. Centrifuge the supernatant at 15,000 X g, and collect the pellet, which contains the mitochondria.
6. No, peroxisomes and mitochondria have overlapping sedimentation characteristics. Other techniques, such as sucrose gradient centrifugation, would have to be used to separate the two organelles.

7. If the protein were cytosolic, once the cells were broken open, you could centrifuge at 100,000 X g, and all the organelles would be in the pellet. Your enzyme would be in the supernatant, along with all the other cytosolic ones.
8. Isolate the mitochondria via differential or sucrose gradient centrifugation. Use another homogenization technique combined with a strong detergent to release the enzyme from the membrane.
9. Tables exist to tell you how many grams of ammonium sulfate (AS) to add to get a certain percent saturation. A good plan would be to take the homogenate and add enough AS to yield a 20% saturated solution. Let the sample sit for 15 minutes on ice and then centrifuge. Separate the supernatant from the precipitate. Assay both for the protein you are working with. Add more AS to the supernatant to arrive at a 40% saturated solution, and repeat the process. In this way, you will find out what the percent saturation in AS needs to be to precipitate it.
10. Reasonably harsh homogenization would be able to liberate the soluble protein X from the peroxisomes, which are fragile. Centrifugation at 15,000 X g would sediment the mitochondria (broken or intact). The supernatant would then have protein X but no protein Y. Freeze thaw techniques and sonication would accomplish the same thing, or the mitochondria and the peroxisomes could be separated initially by sucrose gradient centrifugation.

5.2 What Is Column Chromatography?

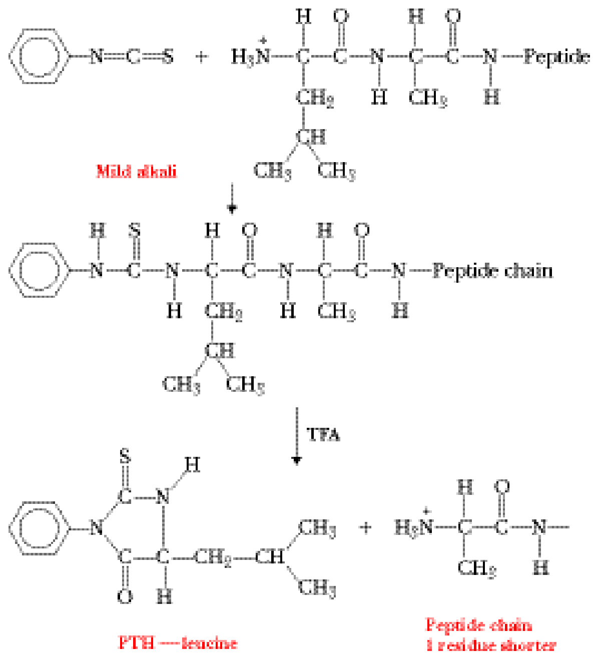
11. (a) Size, (b) specific ligand binding ability, (c) net charge
12. The largest proteins elute first; the smallest elute last. Larger proteins are excluded from the interior of the gel bead so they have less available column space to travel. Essentially, they travel a shorter distance and elute first.
13. A compound can be eluted by raising the salt concentration or by adding a mobile ligand that has a higher affinity for the bound protein than the stationary resin ligand does. Salt is cheaper but less specific. A specific ligand may be more specific but is often expensive.
14. A compound can be eluted by raising the salt concentration or by changing the pH. Salt is cheap, but it might not be as specific for a particular protein. Changing the pH may be more specific for a tight pI range, but extremes of pH may also denature the protein.
15. Raising the salt concentration is relatively safe. Most proteins will elute this way and still be active in the case of an enzyme. The salt can be removed later via dialysis if necessary. Changing the pH enough to remove the charge can cause the proteins to become denatured. Many proteins are not soluble at the isoelectric points.
16. The basis of most resins is agarose, cellulose, dextran, or polyacrylamide.
17. See Figure 5.7.
18. Within the fractionation range of a gel filtration column, molecules will elute with a linear relationship of log MW versus their elution volumes. A series of standards can be run to standardize the column, and then an unknown can be determined by measuring its elution volume and comparing to a standard curve.
19. Both proteins would elute in the void volume together and would not be separated.
20. Yes, the β-amylase would come out in the void volume, but the BSA would be included in the column bead and would elute more slowly.
21. Set up an anion exchange column, such as Q-Sepharose (quaternary amine). Run the column at pH 8.5, a pH at which the protein X has a net negative charge. Put a homogenate containing protein X on the column and wash with the starting buffer. Protein X will bind to the column. Then elute by running a salt gradient.
22. Use a cation exchange column, like CM-Sepharose, and run it at pH 6. Protein X will have a positive charge and will stick to the column.
23. With a quaternary amine, the column resin always has a net positive charge, and you don’t have to worry about the pH of your buffer altering the form of the column. With a tertiary amine, there is a dissociable hydrogen, and the resin may be positive or neutrally charged depending on the buffer pH.
24. The easiest way would be to use a sucrose gradient to separate the mitochondria from the peroxisomes first. Then break open the mitochondria via harsh homogenization or sonication. Centrifuge the mitochondria. The pellet would contain protein B, while the supernatant contained protein A. Contaminants could still exist, but they can be cleaned away by running gel filtration, on Sephadex G-75, which would separate C from A and B, and then ion exchange chromatography on Q-Sepharose at pH 7.5. Protein B would be neutral and would elute, while protein A would stick to the column.
25. Glutamic acid will be eluted first because the column pH is close to its pI. Leucine and lysine will be positively charged and will stick to the column. To elute leucine, raise the pH to around 6. To elute lysine, raise the pH to around 11.
26. A nonpolar mobile solvent will move the nonpolar amino acids fastest, so phenylalanine will be the first to elute, followed by glycine and then glutamic acid.
27. The nonpolar amino acids will stick the most to the stationary phase, so glutamic acid will move the fastest, followed by glycine and then phenylalanine.
28. A protein solution from an ammonium sulfate preparation is passed over a gel filtration column where the proteins of interest will elute in the void volume. The salt, being very small, will move through the column slowly. In this way, the proteins will leave the salt behind and exit the column without it.

5.3 What Is Electrophoresis?

29. Size, shape, and charge.
30. Agarose and polyacrylamide.
31. Polyacrylamide.
32. DNA is the molecule most often separated on agarose electrophoresis, although proteins can also be separated.
33. Those with the highest charge/mass ratio would move the fastest. There are three variables to consider, and most electrophoreses are done in a way to eliminate two of the variables so that the separation is by size or by charge, but not by both.
34. Sodium dodecyl sulfate polyacrylamide gel electrophoresis. With SDS-PAGE, the charge and shape differences of proteins are eliminated so that the only parameter determining the migration is the size of the protein.
35. SDS binds to the protein in a constant ratio of 1.4 g SDS per gram of protein. It coats the protein with negative charges and puts it into a random coil shape. Thus, charge and shape are eliminated.
36. In a polyacrylamide gel used for gel filtration chromatography, the larger proteins can travel around the beads, thereby having a shorter path to travel and eluting faster. With electrophoresis, the proteins are forced to go through the matrix, so they travel more slowly if they are bigger because there is more friction.
37. The MW is 37,000 daltons.

5.4 How Do We Determine the Primary Structure of a Protein?

38. The Edman degradation will give the identity of the N-terminus in its first cycle, so doing a separate experiment is not necessary.
39. It might tell you if the protein was pure or if there were subunits.
40.



41. The amount of Edman reagent must exactly match the amount of N-termini in the first reaction. If there is too little Edman reagent, some of the N-termini will not react. If there is too much, some of the second amino acid will react. In either case, there will be a small amount of contaminating PTH derivatives. This error grows with the number of cycles run until the point that two amino acids are released in equal amounts, and you could not tell which one was supposed to be the correct one.
42. In the first cycle, the first and second amino acids from the N-terminal end would be reacted and released as PTH derivatives. You would get a double signal and not know which one was the true N-terminus.
43. Val-Leu-Gly-Met-Ser-Arg-Asn-Thr-Trp-Met-Ile-Lys-Gly-Tyr-Met-Gln-Phe
44. Met-Val-Ser-Thr-Lys-Leu-Phe-Asn-Glu-Ser-Arg-Val-Ile-Trp-Thr-Leu-Met-Ile
45. It is possible that your protein is not pure and needs additional purification steps to arrive at a single polypeptide. It is also possible that the protein has subunits, so multiple polypeptide chains could be yielding the contradictory results.
46. There are two fragments that have C-termini that are not lysine or arginine, which is what trypsin is specific for. Normally there would be only one fragment ending with an amino acid that was not Arg or Lys, and we would immediately know that it was the C-terminus. Histidine is a basic protein, although it is usually neutral and therefore does not react with trypsin. It is possible that in the pH environment of the reaction, the histidine was positively charged and was recognized by trypsin.
47. It would tell you a relative concentration of the various amino acids. This is important because it would help you plan your sequencing experiment better. For example, if you had a protein whose composition showed no aromatic amino acids, it would be a waste of time to use a chymotrypsin digestion.
48. Cyanogen bromide would be useless as there is no methionine. Trypsin would be little better as the protein is 35% basic residues. Trypsin would shred the protein into over 30 pieces, which would be very hard to analyze.
49. Chymotrypsin would be a good choice. There are more than four residues of aromatic amino acids. The 100 amino acid protein would be cut four times, possibly yielding nice fragments in the 20 - 30 amino acid length, which can be sequenced effectively by the Edman degradation.
50. It would work best if the basic residues were spread out in the protein. In that way, fragments in the proper size range would be generated. If all four of the basic residues were in the first ten amino acids, there would be one long fragment that could not be sequenced.

Chapter 6 Answers

6.1 What Makes Enzymes Such Effective Biological Catalysts?

1. Enzymes are many orders of magnitude more effective as catalysts than are nonenzymatic catalysts.
2. The majority of enzymes are proteins, but some catalytic RNAs (ribozymes) are known.
3. About 3 seconds (1 year X 1 event/10^7 events X 365 days/year X 24 hours/day X 3600 seconds/hour = 3.15 seconds).
4. Enzymes hold the substrates in favorable spatial positions, and they bind effectively to the transition state to stabilize it. Note that all catalysts lower the activation energy, so this is not a particular enzyme function.

6.2 What Is the Difference between the Kinetic and Thermodynamic Aspects of Reactions?

5. The reaction of glucose with oxygen is thermodynamically favored,

as shown by the negative free energy change. The fact that glucose can be maintained in an oxygen atmosphere is a reflection of the kinetic aspects of the reaction, requiring overcoming an activation-energy barrier.

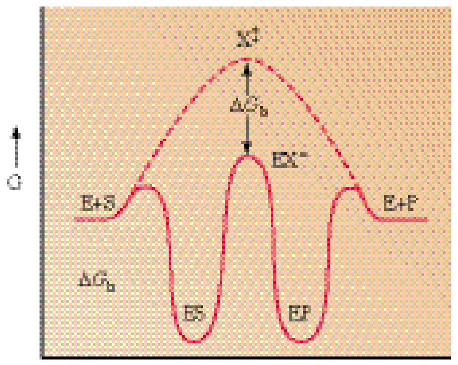
6. First question, most probably; local concentrations (mass action concepts) could easily dictate the direction. Second question, probably not; local concentrations would seldom be sufficient to overcome a relatively large ΔG° of -5.3 kcal in the reverse reaction. (See, however, the aldolase reaction in glycolysis.)
7. Heating a protein denatures it. Enzymatic activity depends on the correct threedimensional structure of the protein. The presence of bound substrate can make the protein harder to denature.
8. The results do not prove that the mechanism is correct because results from different experiments could contradict the proposed mechanism. In that case, the mechanism would have to be modified to accommodate the new experimental results.
9. The presence of a catalyst affects the rate of a reaction. The standard free energy change is a thermodynamic property that does not depend on the reaction rate. Consequently, the presence of the catalyst has no effect.
10. The presence of a catalyst lowers the activation energy of a reaction.
11. Enzymes, like all catalysts, increase the rate of the forward and reverse reaction to the same extent.
12. The amount of product obtained in a reaction depends on the equilibrium constant. A catalyst does not affect that.

6.3 How Can We Describe Enzyme Kinetics in Mathematical Terms?

13. The reaction is first order with respect to A, first order with respect to B, and second order overall. The detailed mechanism of the reaction is likely to involve one molecule each of A and B.
14. The easiest way to follow the rate of this reaction is to monitor the decrease in absorbance at 340 nm, reflecting the disappearance of NADH.
15. The use of a pH meter would not be a good way to monitor the rate of the reaction. You are probably running this reaction in a buffer solution to keep the pH relatively constant. If you are not running the reaction in a buffer solution, you run the risk of acid denaturation of the enzyme.
16. Enzymes tend to have fairly sharp pH optimum values. It is necessary to ensure that the pH of the reaction mixture stays at the optimum value. This is especially true for reactions that require or produce hydrogen ions.

6.4 How Do Substrates Bind to Enzymes?

17. In the lock-and-key model, the substrate fits into a comparatively rigid protein that has an active site with a well-defined shape. In the induced-fit model, the enzyme undergoes a conformational change on binding to substrate. The active site takes shape around the substrate.
18.



No destabilization, thus no catalysis

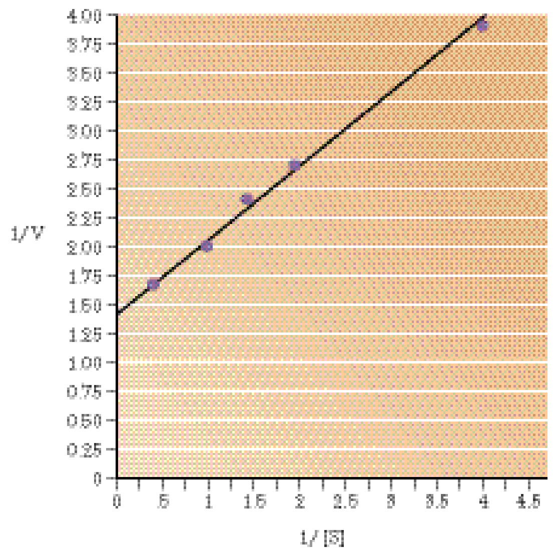
19. The ES complex would be in an "energy trough," with a consequentially large activation energy to the transition state.
20. Amino acids that are far apart in the amino acid sequence can be close to each other in three dimensions because of protein folding. The critical amino acids are in the active site.
21. The overall protein structure is needed to ensure the correct arrangement of amino acids in the active site.
22. The strong inhibition indicates tight binding to the active site. Thus, the compound is very likely to be a transition state analogue.

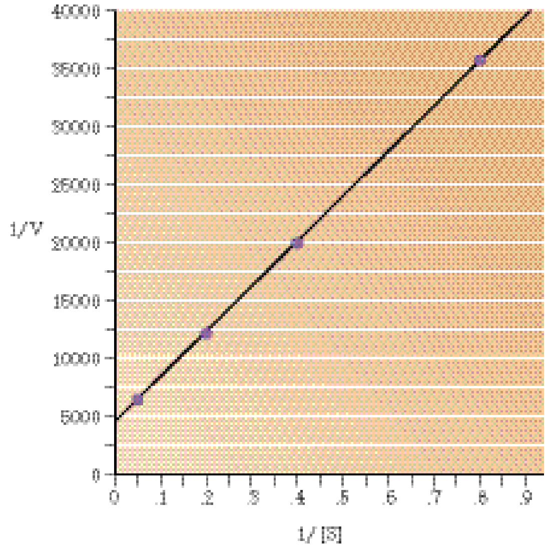
6.5 What Are Some Examples of Enzyme-Catalyzed Reactions?

23. See Figures 6.6 and 6.7.
24. Not all enzymes follow Michaelis - Menten kinetics. The kinetic behavior of allosteric enzymes does not obey the Michaelis - Menten equation.
25. The graph of rate against substrate concentration is sigmoidal for an allosteric enzyme but hyperbolic for an enzyme that obeys the Michaelis - Menten equation.

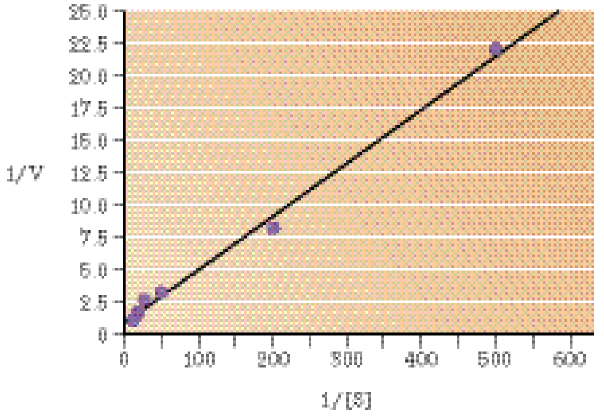
6.6 What Is the Michaelis - Menten Approach to Enzyme Kinetics?

26. The reaction velocity remains the same with increasing enzyme concentration. It is theoretically possible, but highly unlikely, for a reaction to be saturated with enzyme.
27. The steady-state assumption is that the concentration of the enzyme - substrate complex does not change appreciably over the time in which the experiment takes place. The rate of appearance of the complex is set equal to its rate of disappearance, simplifying the equations for enzyme kinetics.
28. Turnover number = Vmax/$[E]_T$.
29. Use Equation 6.16. (a) V = 0.5 Vmax; (b) V = 0.33 Vmax; (c) V = 0.09 Vmax; (d) V = 0.67 Vmax; (e) V = 0.91 Vmax.
30. See graph: Vmax = 0.681 mM min^{-1}, K_M = 0.421 M.

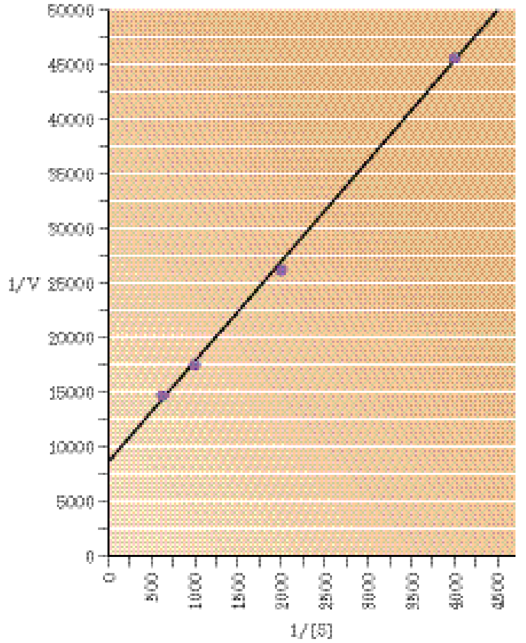




31. See graph: Vmax = 2.5 × 10^{-4} M sec^{-1}, K_M = 1.6 × 10^{8} M.
32. See graph: K_M = 2.86 × 10^{-2} M. Concentrations were not determined directly. Absorbance values were used instead as a matter of convenience.



33. See graph: Vmax = 1.32 × 10^{-3} M min^{-1}, K_M = 1.23 × 10-3 M.



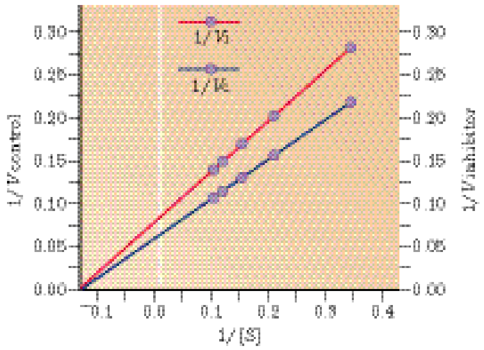
34. The turnover number is 20.43 per minute.
35. The number of moles of enzyme is 1.56 × 10^{-10}. Turnover number = 10,700 sec^{-1}.
36. The low K_M for the aromatic amino acids indicates that they will be oxidized preferentially.
37. It is easier to detect deviations of individual points from a straight line than from a curve.
38. The assumption that the K_M is an indication of the binding affinity between the substrate and the enzyme is valid when the rate of dissociation of the enzyme - substrate complex to product and enzyme is much smaller than the rate of dissociation of the complex to enzyme and substrate.

6.7 How Do Enzymatic Reactions Respond to Inhibitors?

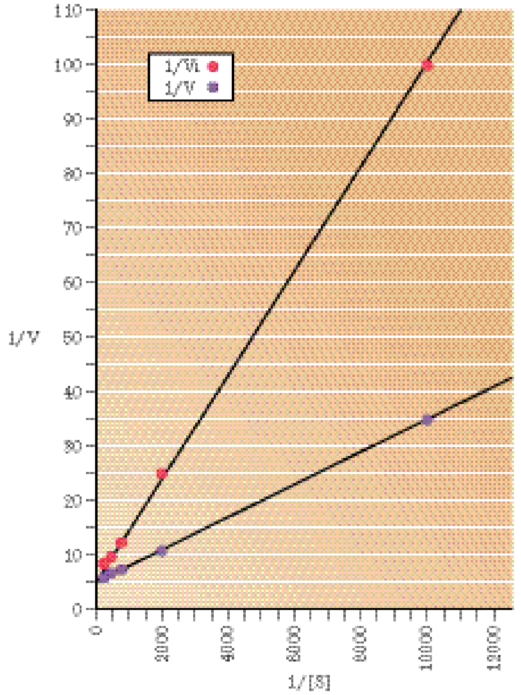
39. In the case of competitive inhibition, the value of K_M increases, while the value of K_M remains unchanged in noncompetitive inhibition.
40. A competitive inhibitor blocks binding, not catalysis.
41. A noncompetitive inhibitor does not change the affinity of the enzyme for its substrate.
42. A competitive inhibitor binds to the active site of an enzyme, preventing binding of the substrate. A noncompetitive inhibitor binds at a site different from the active site, causing a conformational change, which renders the active site less able to bind substrate and convert it to product.
43. Competitive inhibition can be overcome by adding enough substrate, but this is not true for all forms of enzyme inhibition.
44. A Lineweaver - Burk plot is useful because it gives a straight line. It is easier to determine how well points fit to a straight line than to a curve.
45. In a Lineweaver - Burk plot for competitive inhibition, the lines intersect at the y-axis intercept, which is equal to 1/Vmax. In a Lineweaver - Burk plot for noncompetitive inhibition, the lines

intersect at the x-axis intercept, which is equal to · 1/KM.

46. K_M = 7.42 m*M*; *V*max = 15.9 mmol min^{-1}; noncompetitive inhibition.



47. Competitive inhibition, $K_M = 6.5 \times 10^{-4}$. The key point here is that the Vmax is the same within the limits of error. Some of the concentrations are given to one significant figure.



48. It is very good in the case of noncompetitive inhibitors; much of metabolic control depends on feedback inhibition by downstream noncompetitive inhibitors. The question is perhaps moot in the case of competitive inhibitors, which are much less commonly encountered *in vivo*. Some antibiotics, however, are competitive inhibitors (good for the sick person, bad for the bacteria).
49. Both the slope and the intercepts will change. The lines will intersect above the x-axis at negative values of 1/[S].
50. Not all AIDS drugs are enzyme inhibitors, but an important class of such drugs inhibits the HIV protease. You would need to understand the concepts of substrate binding, inhibition, and inhibitor binding.
51. An irreversible inhibitor is bound by covalent bonds. Noncovalent interactions are relatively weak and easily broken.
52. A noncompetitive inhibitor does not bind to the active site of an enzyme. Its structure need bear no relation to that of the substrate

Chapter 7 Answers

7.1 Does the Michaelis · Menten Model Describe the Behavior of Allosteric Enzymes?

1. Allosteric enzymes display sigmoidal kinetics when rates are plotted versus substrate concentration. Michaelis-Menten enzymes exhibit hyperbolic kinetics. Allosteric enzymes usually have multiple subunits, and the binding of substrates or effector molecules to one subunit changes the binding behavior of the other subunits.
2. It is an enzyme used in the early stages of cytidine nucleotide synthesis.
3. ATP acts as a positive effector of ATCase and CTP acts as an inhibitor.
4. The term K_M should be used for enzymes that display Michaelis · Menten kinetics. Thus, it is not used with allosteric enzymes. Technically, competitive and noncompetitive inhibition are also terms that are restricted to Michaelis · Menten enzymes, although the concepts are applicable to any enzyme. An inhibitor that binds to an allosteric enzyme at the same site as the substrate is similar to a classical competitive inhibitor. One that binds at a different site is similar to a noncompetitive inhibitor, but the equations and the graphs characteristic of competitive and noncompetitive inhibition don’t work the same way with an allosteric enzyme.
5. A K system is an allosteric enzyme in which the binding of inhibitor alters the apparent substrate concentration needed to reach one-half V_{max}, $S_{0.5}$.
6. A V system is an allosteric enzyme in which the binding of inhibitor changes the V_{max} of the enzyme but not the $S_{0.5}$.
7. Homotropic effects are allosteric interactions that occur when several identical molecules are bound to a protein. The binding of substrate molecules to different sites on an enzyme, such as the binding of aspartate to ATCase, is an example of a homotropic effect. Heterotropic effects are allosteric interactions that occur when different substances (such as inhibitor and substrate) are bound to the protein. In the ATCase reaction, inhibition by CTP and activation by ATP are both heterotropic effects.
8. ATCase is made up of two different types of subunits. One of them is the catalytic subunit, and there are six of them organized into two trimers. The other is the regulatory subunit, which also consists of six protein subunits organized into three dimers.
9. Enzymes that exhibit cooperativity do not show hyperbolic curves of rate versus substrate concentration. Their curves are sigmoidal. The level of cooperativity can be seen by the shape of the sigmoidal curve.
10. Inhibitors make the shape of the curve more sigmoidal.
11. Activators make the shape of the curve less sigmoidal.
12. $K_{0.5}$ is the substrate concentration that leads to half of the maximal velocity. This term is used with allosteric enzymes where the term K_M is not appropriate.
13. A mercury compound was used to separate the subunits of ATCase. When the subunits were separated, one type of subunit retained catalytic activity but was no longer allosteric and was not inhibited by CTP. The other subunit type had no ATCase activity, but it did bind to CTP and ATP.

7.2 What Are the Models for the Behavior of Allosteric Enzymes?

14. In the concerted model, all the subunits in an allosteric enzyme are found in the same form, either the T or the R. They are in equilibrium with each enzyme having a characteristic ratio of the T/R. In the sequential model, the subunits change individually from T to R.
15. The sequential model can explain negative cooperativity because a substrate binding to the T form could induce other subunits to switch to the T form, thereby reducing binding affinity.
16. Greater cooperativity is favored by having a higher ratio of the T/R form. It is also favored by having a higher dissociation constant for the substrate binding to the T form.
17. The L-value is the equilibrium ratio of the T/R form. The c value is the ratio of the dissociation constants for substrate and the two forms of enzyme, such that
c = *KR*/*KT*.
18. Many models are possible. We never really know for sure how the enzyme works, rather we create a model that explains the observed behavior. It is very possible that another model would do so as well.

7.3 How Does Phosphorylation of Specific Residues Regulate Enzyme Activity?

19. A kinase is an enzyme that phosphorylates a protein using a high-energy phosphate, such as ATP, as the phosphate donor.
20. Serine, threonine, and tyrosine are the three most often phosphorylated amino acids in proteins that are acted upon by kinases. Aspartate is another one often phosphorylated.
21. The allosteric effect can be faster because it is based on simple binding equilibrium. For example, if AMP is an allosteric activator of glycogen phosphorylase, the immediate increase in AMP when muscles contract can cause muscle phosphorylase to become more active and provide energy for the contracting muscles. The phosphorylation effect requires the hormone cascade beginning with glucagon or epinephrine. There are many steps before the glycogen phosphorylase is phosphorylated, so the response time is slower. However, the cascade effect produces many more activated phosphorylase molecules, so the effects are longer and stronger.
22. As part of the mechanism, the sodium-potassium ATPase has an aspartate residue that becomes phosphorylated. This phosphorylation alters the conformation of the enzyme and causes it to close on one side of the membrane and open on the other, moving ions in the process.
23. Glycogen phosphorylase is controlled allosterically by several molecules. In the muscle, AMP is an allosteric activator. In the liver, glucose is an allosteric inhibitor. Glycogen phosphorylase also exists in a phosphorylated form and an unphosphorylated form, with the phosphorylated form being more active.

7.4 What Are Zymogens, and How Do They Control Enzyme Activity?

24. The digestive enzymes trypsin and chymotrypsin are classic examples of regulation by zymogens. The blood clotting protein thrombin is another.
25. Trypsin, chymotrypsin, and thrombin are all proteases. Trypsin cleaves peptide bonds where there are amino acids with positively charged side chains (Lys and Arg). Chymotrypsin cleaves peptides at amino acids with aromatic side chains. Thrombin cleaves the protein fibrinogen into fibrin.
26. The zymogen prothrombin is cleaved to give the active enzyme thrombin. The thrombin then cleaves a soluble molecule, fibrinogen, into an insoluble molecule, fibrin. Fibrin is a protein that forms part of the blood clot.
27. Chymotrypsinogen is an inactive zymogen. It is acted upon by trypsin, which cleaves peptides at basic residues, like arginine. When trypsin cleaves between the arginine and the isoleucine, chymotrypsinogen becomes semiactive, forming π-chymotrypsin. This molecule digests itself further, forming the active α-chymotrypsin. As it turns out, the α-amino group of the isoleucine produced by the first cleavage is near the active site of α-chymotrypsin and necessary for its activity.
28. Zymogens are often seen with digestive enzymes that are produced in one tissue and used in another. If the enzyme were active immediately upon production, it would digest other cell proteins where it would cause great damage. By having it produced as a zymogen, it can be safely made and then transported to the digestive tissue, such as the stomach or small intestine, where it can then be activated.
29. This allows for a more rapid response when the hormone is needed. The hormone is already synthesized and usually just requires breaking one or two bonds to make it active. The hormone can be poised and ready to go on demand.

7.5 How Do Active Site Events of an Enzyme Affect the Reaction Mechanism?

30. Serine and histidine are the two most critical amino acids in the active site of chymotrypsin.
31. The initial phase releases the first product and involves an acyl-enzyme intermediate. This step is faster than the second part where water comes into the active site and breaks the enzyme-acyl bond.
32. In the first step of the reaction the serine hydroxyl is the nucleophile that attacks the substrate peptide bond. In the second step, water is the nucleophile that attacks the acylenzyme intermediate.
33. His57 performs a series of steps involving general base catalysis followed by general acid catalysis. In the first phase, it takes a hydrogen from Ser195, acting as a general base. This is followed immediately by an acid catalysis step where it gives the hydrogen to the amide group of the peptide bond that is breaking. A similar scheme takes place in the second phase of the reaction.
34. The first phase is faster for several reasons. The serine at position

195 is a strong nucleophile for the initial nucleophilic attack. It then forms an acyl enzyme intermediate. In the second phase, water is the nucleophile, and it takes time for water to diffuse to the right spot to perform its nucleophilic attack. It is also not as strong a nucleophile as the serine. Therefore, it takes longer for water to perform its nucleophilic attack and break the acyl-enzyme intermediate than it takes for serine to create it.

35. His57 exists in both the protonated and unprotonated form during the chymotrypsin reaction. Its p*Ka* of 6.0 makes this possible in the physiological pH range.

36. Instead of a phenylalanine moiety (similar to the usual substrates of chymotrypsin), use a nitrogen-containing basic group similar to the usual substrates of trypsin.

7.6 What Types of Chemical Reactions are Involved in Enzyme Mechanisms?

37. They act as Lewis acids (electron pair acceptors) and can take part in enzyme catalysis mechanisms of enzymes.

38. False. The mechanisms of enzymatic catalysis are the same as those encountered in organic chemistry, operating in a complex environment.

39. General acid catalysis is the part of an enzyme mechanism where an amino acid or other molecule donates a hydrogen ion to another molecule.

40. S_N1 stands for unimolecular nucleophilic substitution. The unimolecular part means that it obeys first-order kinetics. If the reaction is R:X + Z: → R:Z + X:, with an S_N1 reaction, the rate is dependent on the speed with which the X breaks away from the R. The Z group comes in later and quickly, compared to the breakdown of R:X. S_N2 stands for bimolecular nucleophilic substitution. This happens with the same reaction scheme if the Z attacks the R:X molecule before it breaks down. Thus the concentration of both R:X and Z: are important, and the rate displays second-order kinetics.

41. The S_N1 reaction leads to loss of stereospecificity as the X group leaves before the entering nucleophile. This means that the nucleophile can enter from different angles leading to different isomers.

42. The results do not prove that the mechanism is correct because results from different experiments could contradict the proposed mechanism. In that case, the mechanism would have to be modified to accommodate the new experimental results.

7.7 What Is the Connection between the Active Site and Transition States?

43. A good transition state analogue would have to have a tetrahedral carbon atom where the amide carbonyl group was originally found, since the transition state involves a momentary tetrahedral form. It would also have to have oxygens on the same carbon so that there would be sufficient specificity for the active site.

44. The induced fit model assumes that the enzyme and substrate must both move and change to conform to each other perfectly. Thus, the true fit is not between the enzyme and substrate but between the enzyme and the transition state of the substrate on its way to product. A transition state analogue will fit the enzyme nicely in this model.

[illegible]swers to Problems Chapter 1 Answers 1.1 What Are the Basic Themes for This Text? 1. A polymer is a very large molecule formed by linking smaller units (monomers) together. A protein is a polymer formed by linking amino acids together. A nucleic acid is a polymer formed by linking nucleotides together. 2. Catalysis is the process that increases the rate of chemical reactions compared to uncatalyzed reactions. Biological catalysts are proteins, [illegible] exceptions are a few types of RNA, which can catalyze some of the reactions of their own metabolism. 3. The genetic code is the means by which the information for the structure and function of all living things is passed from one generation to the next. [illegible] The sequence of purines and pyrimidines in DNA carries the genetic code (RNA is the coding material in some viruses.) 1.2 What is the Chemical Nature of Important Biomolecules? [illegible] The correct match of functional groups and compounds containing that functional group is given in the following list: amino group $CH_3CH_2NH_2$; carbonyl group (ketone) CH_3COCH_3; hydroxyl group CH_3OH; carboxyl group CH_3COOH; carbonyl group (aldehyde) CH_3CH_2CHO; thiol group [illegible]; ester linkage CH_3COOCH_3; double bond $CH_3CH=CHCH_3$; amide linkage $CH_3CON(CH_3)_2$; ether $CH_3CH_2OCH_2CH_3$.

[illegible] The functional [illegible]

[illegible] compounds [illegible] Before 1828, the concept of vitalism held that organic compounds could only be made by living systems and were beyond the realm of laboratory investigation. Wöhler's synthesis showed that organic compounds, [illegible] like inorganic ones, did not require a vitalistic explanation, but rather they obeyed the laws of chemistry and physics and thus were subject to laboratory investigation. Subsequently, the [illegible] concept was extended to the more complex but still stable [illegible] discipline of biochemistry.

[illegible] Urea, like all organic compounds, has the same molecular structure whether it is produced by a living organism or not. [illegible] aldehydes, ketones, alcohols, and their [illegible] oxides and ethers [illegible]

[illegible] Can chemistry say anything about the origins of life? [illegible] It is generally believed that carbon is the likely basis for all life forms [illegible] possibilities [illegible]

[illegible]

[illegible] to have at least [illegible] possibilities [illegible] The number [illegible] 2×10 [illegible] RNA is capable of both [illegible] coding and [illegible]

8.2 What Are the Chemical Natures of the Lipid Types?

2. In both types of lipids, glycerol is esterified to carboxylic acids, with three such ester linkages formed in triacylglycerols and two in phosphatidyl ethanolamines. The structural difference comes in the nature of the third ester linkage to glycerol. In phosphatidyl ethanolamines, the third hydroxyl group of glycerol is esterified not to a carboxylic acid, but to phosphoric acid. The phosphoric acid moiety is esterified in turn to ethanolamine. (See Figures 8.2 and 8.5.)

3.

4. Both sphingomyelins and phosphatidylcholines contain phosphoric acid esterified to an amino alcohol, which must be choline in the case of a phosphatidyl choline and may be choline in the case of a sphingomyelin. They differ in the second alcohol to which phosphoric acid is esterified. In phosphatidylcholines, the second alcohol is glycerol, which has also formed ester bonds to two carboxylic acids. In sphingomyelins, the second alcohol is another amino alcohol, sphingosine, which has formed an amide bond to a fatty acid. (See Figure 8.6.)

5. This lipid is a ceramide, which is one kind of sphingolipid.

6. Sphingolipids contain amide bonds, as do proteins. Both can have hydrophobic and hydrophilic parts, and both can occur in cell membranes, but their functions are different.

7. Any combination of fatty acids is possible.

8. Steroids contain a characteristic fused-ring structure, which other lipids do not.

9. Waxes are esters of long-chain carboxylic acids and long-chain alcohols. They tend to be found as protective coatings.

10. Phospholipids are more hydrophilic than cholesterol. The phophate group is charged, and the attached alcohol is charged or polar. These groups interact readily with water. Cholesterol has only a single polar group, an —OH.

11.

12. The waxy surface coating is a barrier that prevents loss of water.

13. The surface wax keeps produce fresh by preventing loss of water.

14. Cholesterol is not very water soluble, but lecithin is a good natural detergent, which is actually part of lipoproteins that transport the less soluble fats through the blood.

15. The lecithin in the egg yolks serves as an emulsifying agent by forming closed vesicles. The lipids in the butter (frequently triacylglycerols) are retained in the vesicles and do not form a separate phase.

16. The removal of the oil also removes the natural oils and waxes on the feathers. They must regenerate before the birds can be released.

8.3 What Is the Nature of Biological Membranes?

17. Triacylglycerols are not found in animal membranes.

18. Statements (c) and (d) are consistent with what is known about membranes. Covalent bonding between lipids and proteins [statement (e)] occurs in some anchoring motifs, but is not widespread otherwise. Proteins "float" in the lipid bilayers rather than being sandwiched between them [statement (a)]. Bulkier molecules tend to be found in the outer lipid layer [statement (b)].

19. The public is attuned to the idea of polyunsaturated fats as healthful. The *trans*-configuration gives a more palatable consistency. Recently, however, concerns have arisen about the extent to which such products mimic saturated fats.

20. Partially hydrogenated vegetable oils have the desired consistency for many foods, such as oleomargarine and components of TV dinners.

21. Many of the double bonds have been saturated. Crisco contains "partially hydrogenated vegetable oils."

22. There is less heart disease associated with diets low in saturated fatty acids.

23. The transition temperature is lower in a lipid bilayer with mostly unsaturated fatty acids compared to one with a high percentage of saturated fatty acids. The bilayer with the unsaturated fatty acids is already more disordered than the one with a high percentage of

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nd. hatloe simalle to powi th her. ptris 0 water ?i d the det in ition ofp his pi o dHi+ dletot, e lose inct ionach angeinco ncentra ti onoflow ii lea dtoa chalse i pH o fi 1 th e (i0sori os sl no the.

0.0 fl oo is2 ?etd 17 lb10 dp l as llla? Ph7 (H+)=10 l0X 10 Mo rang e jui ce ? pH35 [H+]

2X. 0■ 4 MHum-li line ? pH6 l 2[H+]=6l3 X 10 ■ 7M Ou seb1 dalnlon ia ? p H11 5[H+]=3 l.

X1. ■12Mcastrici uic epHu f3[H+]=1 l 6 × M 2Msa livi pH6 5 [H+]=3 ■

2X. 01 7Mntfacelhu iar fluid ue piPH 1 9[H+] 16 × 10 7 tomato juice pH 4 [H+]=6X10

5M. raperruitjuice pH 3 [H+]=3X 10 4M sai li va pH 5[OH]3 12 1 ■8M intra cellula fluid pH 3 [OH]=7 9X10 8 Mtomato.

ui. e pH 3[OH]=2 10 X 10 ol gr ape fruit juice pH 3 [OH]=610.11 lb 16 wha t are b le ferson dwhy are they important? 1 the roof the lbiff.

rshould becioset

0. he desir e d bu ffer pH ? a ltnesubs ta nce sho uld

1. lbti mel fr with there lcuioni n 21 T He us e fulpH range ora b ufferisou PH lintab oveandbe low its pKa 2 lse therefers on masse alche eld tion(H+ [A-] ■ (HA) pH3 0 lc 14 7+log (CH3COO-) 3 (CH3COOH) 2 4=10 &(CH 3 COO)3 ■ (CH3COOH) 3■ ■ inv erseio forO. 24 17 &CH3COO12 3 use the here the ratio of phase raic clea, ti on PH= pKa+lo g(CH 3COO-)

0.4 76+ lo gCH 3COOH] 76=lo g(CH3COO-)

i. vers0 f ■ 76 1703 =4 use th e flede r, oflla ssettle leh eq ui.

i. pKa+10 s(TRI S)= + lo s(TRIS)3+10 s(TRIS), +10 4 lo g(TRIS) inv erse log 0 4
■

1
2

t. lys is a lo lstri vingorgs, nimst carryout chemical reactions in lich the efficient lyt hawit. outc at aly sts 1 4 two of th ef stow io Usaayatage.

a. esp eeandsp ec ifi city the iasowork atco ns tan tth etratur e

1. heat ? 15 co dinga1 ow s forrep ro duc tionorce ll s 16 wi thrspe ct ocol.

8. lna the for in ucle ot ides h ave perfor ed u e d ifom the nome ssi the absence of (i the mpre exis t in genato tcotte coffee. Zym e toca tai yze the process. Th eo bserva tion tha tome a list i nsk nabole c ilesc an cat a lyz e t heirownpr ocess. sS u ggests t hat o le nrnaincat alysis lith the aul l o dnatury, ave be en the ori gia nl floor ma t ion lth the ecor, s llif e cells cellslsu likely that cells couldhav ea ri sen s affect yup i a s m with u outa p l a s membr and t hepres enc eofth emem brane prote ctsthe ir ua r ollPonen. sfro m the nvi ro nme ntand ever its the from d i s, ijs na fr omeach other. The lbi eCu.

e. With iflcenc nuc lec tuiores i lyith vareclos, rtoaclh, the r- 14H ow dop rokaryotesan deukaryo tes d i ffer l hevel is ofs, 8 i fiVed iff ere nce st wee n. rokla otesand eukar yo tesa re (1)) prokaryot s d n otha.

ea. ell ne finfa mcei eusi n leu kar yotes have nuc leus arke do ffrom theres tofthe ce l by a double mbrane (b) prok ary ote s V t ny ar lasa cell me mbrane eukaryote sha ve an extensive inter nal membranes stem (3).

5. Eukaryotic cel i s con ta i n the ry an e m bound de for fane lles? wh i

eproke ar ot i cce ll sdonot (b) euka ryotic. e l l s are form all y r ger the n t hose of prokaryotes (5) prokaryotes a re si ngle c e l l e organisms? which eukaryo.

e. ca n be multi cellular as well as

5

si. gle ■91 rt.

in. ythesis ta ke s pla ce on ri bosomes in theor the cyto l es and eu.

ry. tesi. nedua ryotes in bsomes may bebound to the endop las mi creticu 1 um or foundfree in thecytopl.

sm. inprokar yotes ri bosomes are fo ound free in thecytopla s m 1 5 what are the main fea tures of prokaryoti c

ce. ls? 20 iti s u l ikely that the chloro plast a w ou l d be found, in bacte ria l th e euk ar yoti c organ e l l e s are e en c los e d b ya d o ubl em.

mb. ane ? and a c t i a doltth ave a ttai ner nal mem bran esystem wh ell ito chondria lso. lhi neulayo ticc e l lthea bolth es am esize as lhosts 1 1 6 what are the main structural features of eukaryotic cells? 2 1 ts these cilonin 6 for the functions of the organ in mal cell? wh i c h parts of the plant fi gure lo c 21 2 l s e e s, ce lls of the functions of the organ the plant ce. 11 wh i c h are structures hrown in plan em brane s sem for ch.

or. Pras the wh ich are the r esembr a l e be ic lose to ra ndeesl ne p o tsy nthe tic bac teri a the.

ea. ee xtensions Or t rep ll smalle n ra l nei no-i n teri oro fthe e l l ci dled on r- ma0 ore sy w h ch a re the side fph otos nthesi s 24 Nucle i ymi toch ondria and chlor oplas t s a re b o un dedby a dou.

em. 5 nuclei, lia toc ho ndria an dchlorop l ast s a l l conta in dna at dna ou ld a i m i t ocho ndria nd ilic hlor opl as ts a i ferrsf romthati nthe 26 Mi toc hond ria carrylout a hi gh perfle.

ta. e fth e xi dati nener g y a te si ng reaction fo r the ce ll the ya r e the p r i ma ry s i tes of atp 27 Thechloroplasts r ea tu s i n vol ve d i n t ai n i n g car0. y ra t es t o P o t e l n s a l th e m ex p o t h e ir b il ll o n e s f rom the cel l y s o s omesc o nt ai n, a do lt i c e lly mes ? fe ro xisomes o f t i.

ca. a lacne calo ro the le th o li sm o f p e roxides h a l y 0.

ys. mesco nta le rzy mes ne ed ca ly p h a ts 0 rth e s l yo r a t e cy c le r a l t e so r gan ll es h av e t hea p e ara n c e of.

la. ten ed s ac s bou nd ed b y a si n gl e m e l brane 1 1 7 h o w d o w e c l assi fy or g a n is m s g i v e n k i n.

d0. s or th e e 28 l o n ti n c l c h a r a c t e r i k e l s , E c o l i a n d c. an eSCri Pt iOn OFh Owmuna GiaCH AdiSS Giate, to hYar oeen i ol cOThEP r0 Per ty ora more cd let hatha SbOtha r01 arre sionan danOne 0 iar, esi oni cd T,

ea, OhtoraC iao rhiS e thIt Carnedaid edt0 a buf reriefor eeX rerien cinaSha, PPHCh anstl ce) TheP 0 intiatit rationC UVe whefet heada edacidnbse qu, 1Sth ta mountof bll fefrornin a ilypre sen tl C D Thetropertyoramo lec U1e tha tis rdaily sOmbre i nwa- erdi el 4 W iChintr -h-S - 0 -ime sleS, Ufre fin gcapacit Ytiant hethitlal, thre Ebuf ferSh avetsa ne Hisi n - e - heYal, have thesaffere lati ve aounsOft he aCi danabaSero m 45 It, OU1 demorter fe ctiv Etos tartwitit E HEPE sa Sel yoUwantabuf feratap Hab Ovet hEP Kbvhic hme ans tha tuebaSerOmw 11pred,

mi, atewenouiafer i nis hebrerarin siu itise aSie t ocoffers Om eOr theraSer of itto theaCi d rom, namost oftheici- rOrmbt hera Sefor m 4 1 ra nf fe with th EPH ove therkas the hSer or mPed omi plates thi SwOU1 dhe UsefUL, Sab ufer for a ra ctio nthat ro tiuC esH beca usth re Wi,

1b, Ple ntyoftheb aseror ht Ore act withtheh'd t0sen0 no rodUce- 47lzwi tt, ri OnSt enino ttoi nterferew thisoche mi a 1re action sl 4 8 1t iSUse, U1t ohavta burfe re natwi1maitt ainastablepie ini fassa, Cond i tionsChan sed i 1u ti diSOn,

SU, hPo ssibiecrsn se 4 1tis usefh tOni ve abufer, hat, ilmain tain asta ble PH evelirits, sayCofdi tiOn SC hanset T, mPe rat- revtiri a ti OnSiSone sucho sSiv bl eCha Se, 50 TheOm1 yzW ite io nis +H3 N-CH2,

Chapter3 Answers 31 Wha tare AmiNo ACiDs, yalwhati S h

ei, Thr ee0 ifinsiOnaL D mna aminoaC idS haVe di fferentS t ertoChe,

iS, rYa rounath ea Ca rbon Pepti d estiatC ontain pamina CidsarefoU nd in b acter i a ice1, Wains and i nso mean ti b iot icS 3 12Th, tare the Stru ct Ure Sa naproper tis, the Indivi du a1Am ino ACid S 2 PrOline, is technica 1lyno tan ami noacid G, Yci n eco ntainS n C hiratc arO, tOmS1 AnAmi macidn whi chtheR gtoupcon tai nst hefoll owi ng alydroxy lgr oupselinet, hreo nin eTyrosife Is Ufura, OmeCiS te iNe lethioiifes aSe CuhDch- raica robnatO ngiso le Uf ile t breolni, ea nam ino fouri 1yS iNe iana mi de ol p aspara gin, s1 ut am ile ala CidgrouP, SP artate sUltam at ea rOma tiCr ing PhenY1a ani ne t rosi- etrytoPla rbabr atChe disietna inC teu ine vali,

e) 1 Inch epe Ptid e val nne tsern1 iem Hemarks Ts hy reneu the rOuram, ooaC ids a rest i ArgCys alrhry- thea roma tic amp aC i asrPha narryr and the su lfurCo ntai ni neAM n O Ciasar eM etnacY 51 In the Pept ido Glh- va1 Asp li esela Ala t he N n bla amin 0aci dsa E va 1 1 e anala tha c i ica mi na cids a re61 ua daSp A miO acids

th, rthantheus ua12O ar ePrO ducedb ymodi tiCa tiOnrOn Off- eCum ofnalno, C id ise elig u res rfor thest ru cturre sofsomenai f- eta min a ciasy H Ydr0 xy P ro 1 ina n dhYdroXy1 YS ine fepro un di c On as eht, Yrox ineiS roun dint hyro sioulin 1 T Ty, OSine tr ypt op han a thithi r de rivati ves s Amon am ile Oxi dasei sa fe Zyme th-

ties, adeSCompo undsWithinam i nosroupin cludingne Urotr an s mitters, conseq ent 1 th e yCan con tro la per SOn S e nt aista, eDi Th, is h Concen tration, f trypt ophani nmi ik pr oteinmay maid1 yelev,

te, heievei sof serto ninwhich regulesthe b ra in 10 Th ety- tophani nmil kmi s h tnakey 0u sleep we reasth, tYr a im ne inc he ese sh OU1 dbe y ou whi h eamin oaCids thyrox in an dhyd, OXypr olineO cCUri nveryrew proteinst Theg enetic Cod e does n0 ti fic 1u,

e,h em Sotheya reproducedby m0di f i cat iOnrt yr, S-n e and proli ne res Pe Ct ively 1 3 3D, AminoaCiS Have sptti fica tiaB, Se Prope rtie s 14 i Hi Stidin e i midazole is dep- otonate ina mino s r0 UPi sRe do m- i nant i yeP,

0,0 nate di A SPa rasine mminOs r0 UPi sde Prob nated rrypt

OP, an mminos r, UP i sP r d0,

in, nend epriton ate di Proii e a minosroUPi spartia 1 1Y de Protonat ta ip1 osi n e amino s r0 upisp red omi na, t iydeP fo t onate d phen o iiChydroxy1 isappr oximate1, a 50 5 0mi xt ureof protona ted and deProto nated 1 5 ise ict ri CPO,

nt, orsl t ami cac id3, 255 S crine 5 1 his,

id, ne 7 1 58 ly Sine 9 75 t yr osine 6 sarsinin 0 1 0 1 7 5 1

I C, Ste inewi 1h aVenon-charsea tPH 02 (1 7 1+8 3 3)/2 (S fti tra tion Urve he 1 owpi 7 pH 8 6 0 8 pH 3 3829 Af trmi xin gthebu, fe iSolut iOn 1 oom b On ainso 1 2 5M1 actic acida, d0 7 5Ms oiuma lacta te, ePka Ofac ticaci d is 3 86 U Set hen der sOnna Se ibacheuati o nPH=pKa+ 1o (CH3-),

3 H= 3 86+10(CH3 1 PH=3 8 6+ 10&0 7 5 0 25 pH=3 86+ co 4 pH=4 3 430 U,

et, e Hen dersonHa Sselbaic hequati onpHp a +10S (CH) (H3, PH= 4 76+1 o (CH3) PH, 4 76+ 10 C0 25MD 0 1 0 MD PH= 4 76+0 4 0 PH 5 16 31 Yes i tiscofr ect Calcu, ate them oi ara Molutsof-hetWof omsandi nse rt intot, eHe nderso nasse 1 b alcheq uati On 2 02 0 1 0 16 7 5 25 0 33 mo 32 Th esoluti o ni S abufre the Ca useitcon tainsequa1Co nc entratio n

S0, TRis intheac idandreami ne forms wh enthey solut ionsar e m iXed the CO ncent r-t ion S-f thereSultinsS, 1Uti Oni nitab Sen ce ofre act ioNare1 os Mechlo, 1Mr R is ica ustor i ilti on Thetri rea ctsw,

th, a rtherr is pres ent Vi 0 5M tri sp rot ate d mo and 05 MpriS (r e a m i ne 1 3 any buf fertha, hSequa 1c onCentra, ionsofthe aCid ndba sic forms, 11h av eaPHequa 1 to i tsp Ka The re forethe bufferfo, exe rcise 2 wi11 ha VeapH0f8 3 4 first calculat,

th, m0 1 eSofbufre rth aty oune Ve: 1 oom L 0 1ni tersan do 1 i tsofbu imr risbu frerisdo 1lmo 1 esisin, e thebuff er isatits pK- the rea ffe equa 1c onc entra tiO nsOftha cid ndbasicformS oNe a mount of TRIS iso 05 I0 i es a ntheamounTof

RI, 1+1so 005 moLe S i efOLdn 1 ads mL OF 1MH c1 youwi 1 beaddin 10 3 m0 les, fH+ Thi S wi i1react as show n TRis+ H+ unt

istHeH, n deIS-n H 8 Se ibaiC e qua t onP, =pK a + or (H EPE S), H+ 1 9 7 5+ 1 0 c(H, pes) H 10 3 ior(HEPE, b H HEPES, =1 ii ve iSe 10 rof 3 5 2 1 26 A tpH 7 5 1 the rati,

Of, HPo 42-4nis 2/1, PKa, H2, 7 2 a s calcu1at edis in shthenenie- sOnnn Ha ss elha ichequation K2 4 isas Ou rceof thebasefr rma ndicm Ust ea d edtoConv er tone hdirao ri itto theacid forba cCor- ingtothe2/1, ase/ac idrat i ol weishu,

8 7 gram S0 fK2HP04CO

10, m01es baSe dona r0 rmuale ightof174sr ams/m o1e)

d, SsoIveinsm a 1 qu antityofdis ti 11e dwa ter a dd 1 17 mlofi, HCl gives1/30 fo 10 5 moles ofhyd r0 gen ion wh ic hconvert, 1/30 ftheHPo 5 mo 1e sof HPo4t of 2 H2Po4 and i 1ute the re sult, nsix tuf tone1i ter 27 A 1 r ati 00,

t, en1se, Or matiaci dormi, sti line ed al hecause the PHO r t

h, buf feristhesa me i nb othprob 1 ems N aH2P04is Source ofthe aCidfor ma NaOH ist b, add ed to conve rtwoth i rdsofitto th e ba se form weishou, o s ral sof NaH2Po,

05,0 1es bas edo Na formu la weightor120sra ms/mo1e aiss ol v

e, nas ma 1 1 quanti ty ofdi sti lled te r add 3 3 3 m 10 1 m NaoH gives 2 /30 fo1osmo1 eso fhy dro xide on which conve rts 2 /30 fthe 05 mo1, sor H2PO4to HPO4 and i 1ute the re sultinsmixtur etonelite r 28 A fter mixin g the buffer so1ution 1 00mL Contai ns 7 M1 acticacid an d o 2 5 MSodiumlacta te the pKa of lacticac idi s 3 86 Use the Henderson Ha sse 1 c h equ atio n PH= pKa+1 0s(CH3 pH=3

6, 1 os (CH3 3 pH 3 86 +los c0 25M/0 75 M 5 1 1 1 What is the conn ectio netfeed The m dern, c sa n deli re4 The lower in sore n ropyne deat 0,

i, er isto ge esteas stoisie re n trop h t ieS Urr, unain ss thu sincre as ingthen trop yOf th eun i verse aswho1e 45 Com par tmenta lizatio ni Of,

a, e1es bring sCo npo nentsOf reac tion sint o pr ox i mi t Wi thi e,

n, the Th e fe rS Ychanseo -thef act io ni sno taf fect eable tleava ilabi ity ofcofpo nentS a i1 Owsi ntop ro deed ort, eadi 1 y 46 Dnwo1 dhav ehi shereftro py Wi thte stran d Separate T, ere are twosi Nse strandsins teadoro edoubiestra nd and,

h, Singlestran d havmor econforma tiOn ahnobi i it Y 4 See thean Wertoe xercise 43 Itissti 11un,

ik1 Ythatcel1s COU ldhaveans enastrre Cyto Plasm

bll, the question of Pro xili ty ofre actants is no Ie to theroilither

th, nth eeleroscia ne of dsivar e acti n 49 I t, OU1 d unlikel yth at celso ftheki ndWe know Ou ld haveevolvedonag, ss antt he a,

k0, S01 i ds andliqiid s0 n Whi c hgsre sat es cou 1dr 0rm w0 uid akellar geaiferenceI 49 Th dv ai1ab i1e materials ire fr om t hose, at wOu1dha ve beenfOun do, at ra th ea nd condi ti ons oftthe Pre- ature a n d pre ss,

re, rev ery differ ent 50 1 MaS becauseofc ondi tionSmore, iket hos-

oCea rth i sli mu m brane r e, e rctical 1 y av Oratle inte ra ct io nSar ive theproc essofo rod tein fol d ings ulti mate1 ymcreasi ngth eentropy Of th,

un, 52 Phos y th esis Sender o nic re quiring th enenergyof o11 the sun theCo mp ie tele r o yiCOxid,

ti, nor shucos ei sexer goni ca ndi saso urc e o fe n eroyfor ma n yor- ans m, in c1uding hu1ans u W 0U1 d er e s 1nab1 tos pe Cthe thO P 10e Sses Ot a ear acea ifer ntn vi tOra etopr 0vi d eener yf ortbc e n d ersoni cone Cha, ter2 Ans wers 2 What ti SaH ydrose Bb, P, Ot,

in, ana hici e cac id s haVeh yd r0s en o nd sasan i mpor tantpartOrt hei Stru, ture S 2 ReplicatiOn fDNA and i t Stra nscr iption t

OR, Are qui re shydrose n 'onding s rCo ple ment ary base s tothe a- emplatestr and 31 T hec-H Onding s o ts ufficie n t u y PoI a frorsrre a t i y in 01 un listi b ti onore iect ion sati stst Woen dsi Ai S th e rearen Ohsira1fea,

ai, sorrectthis toSertas1ya fo s enb on d acceptor s 4 Ma1ymo, lec ule Scan for mh ydro se b Onds Examples mig ht ee CH3 OH H3, 51F Ora b ON atoms Ca11e dan hydro sen b ondin itius, hav e 1 d r0s nco vaientlyb o, d too, Or th is ir ora gthe n forms, hydrosen bond- ita ther o-N0r 6 mhy drosen, Ond e d i ner, Ofa ce tica,

id, he O H rOrti onofth ecar box yl sr oup 0 o mol ecu1 eisp nd rsen b onded to th- r o rti on o f the c arboxY, gro up O fm olecule 2 a n d vice Vers a 7 1 u Os e i 7a na S orsi 1 8 i bito, +1 Sic acia Co ho i sr ou Pca n o nd tto waterS, nitr i e oxygen itt Othoi- hesu gra 1 co fo i sbi nd ror eth an the o rr es pon di ngsu,ars 9 H P0 e,

ti, ati onecr eases the PH 0 rblood i cree fsc onpi s s i ps i rijise- e ctrical, Yntutra, ratheroret hes tom a cla n, anP as tre mbr ane ree l s i n the re ana li nt hes fla 1 int est ine,

o 1 p S i ti v1y chars ed i onsw, 11 bi i ation-cheicaci ds asares ul t of e e ctrostati ca traction tothene,

at, vel Ycharse dphosPh ate i th e lin ie ne ri tine,

S0, Wat er for r or mi n shydrosen bo na s deter mi nesth eP rop er tieS0 rma nyi mportan t bi omo1 ecules,

Wa, ercaills oacta sa na Cid an d ab aSe gi vingits r e tversatil i ty- higioche mi ca1 re actions 1 2 1 at om ssi doitaffectinelec troneg ati,

it, therewou 1 dbe n0 m iar bond st h is wou1d drasti ca1ly a ffect 1 1 react ion s th a ti n 1 0 i ve rufeti 0nal s r oups co, ai ning o x ygen0 ni trose n th ati s mos t 0 2 3 wha ta re aC ids andbase 1 C,

3 NH+c On juSate acid (CH3)3 N (C0 n jus ateras

e), H3N- CH2 COOH CONJUSATEACID H3N-CH2-COO (Con ju gate bas e)+ H3N-CH 2- COO C on ju s ate acid H2 N-CH2-COO (Con, u sa te bas e) (H3N- CH2 C, OOH con jugate acid, (H3N-CH2-COO (Co njugate bas e), H2N-CH2-COO con jugate base) H2N-CH2-COO (c) c o njusateaci d (d) the

Um, fi C, ic, tan te r tot heCon ce ntrati onof the rPo d ic tso fthe diss oCi ati on i videdby, t he Con centrati o n of the unissoci at, ed acid form (a) HA (b) The qua1i ta tive o f qua nti t ati hey occ., rimpa tures in anti bi o ti c and b act erial ce llw all s is 50 T heai ffe ent, tere oche mi s t r of the twop t p tide siead sto diffen t entb, ndi ng with taste re c ept O.

sa. dt Oth, swetas te froneandh e bittertas te fortil. the pr o pter 4 ansW ers wi th the str uctur of Protein Det ermin th e i Ction? .

de. ature d th e inter ac t iOns that determin e s ec ond a ry ' t ertiary and a n

qu. ternary structure sare o v e r come by the presence O f the d enature in g e nt on y t e ptimir.

st. u cture remain s in act is i T h e r and om portions of a pr o tein d O conform a in tructural mot i f s that.

re. e peat ed with in the prot ein's uch as an helix or p leated he t ; but thr ee amine id o nal red tures. the separts of th e prot ein are repeate d er on or emore cult erd anot ter th us th e term isso. eWh at of a lis noll en 2, hatS the prima rys tructure of prot eins ?

When a prot e in isco.

al. ntl in o d i ffe ent Spl im ary stru ct ure is ch a nged. The prim ary St ructure deter mines the fina l thre e dimen sional stru cture. Other epr ot ein modific at ion all group ist hefol in g s, erine as a splice, hat the a ffe it ina l yre lati vel Pol r amino pe ti de Tr ypt o Phan has the l arges tsi de chain of any, of the con m amin o ac ids and it.

en. Stor e quire a lon p o lar n ami no n e tu (o l ys ine, and arg in ine are b Oth basic a mi no aci d s: e ch, ni ng O f t er ort heo ther w, ul d b tar fec t the side chai n P Ka? . na sig nifica nt way is i lar rea so n in g a, Pl is to thes ubs tit uti on o f ald n p olar iso.

eu, i ne r or a n o n polar neu t ine 6 i g l yci ne

is. frequently a const y cre side t e cal s t s ide chains, s l a ri as t o ri ti n spaces th at, i l in.

ta. co m moda tel are one s 7 ne pla lani ei sre p a c ab y s o le t r m t h er eis ma tion. h ro o min the lative c o n nor mat ion for th ar g e r i de chain o f the i s o l euc ine l cons e quently. there is a re ate, ou ge that ge in t he conforma t ion the p r o f e i n tha t it l o ses a ct i vi ty.

ng. y Gle iss uus ti t u ti n ntu p t o r i s o l uti e ne th e pr. se n e oft e small e r side chain e ad s to res u mpti on of t reac ti v ec. n f o r m a t i o n s m e a t c o n s i s t s i a r e i y t h e i n i a e r o t e i l s a.

df. the temp er at ure s i e the c o n f l e r a t e t i d n s e p a r i l a c t a s a b u f e r i l t h e p h r a n g e T h e y h a v e a n e t c h a r g e a t p h e x t r e m e s , a n d t h e m o l e c u l e s t e n d . e p e e c h t h p w h e n t h e m o l e c u l a r c h a r g e i s z e r o.

th. ami no acids Cana re sat e n f r e e as i ly, 20 h th e i o n i c d i s s o c i a t i o n e l e c t . On s o r t h e f o 1 10 w i n g a m i n o a c i d s : a s p a r t i c a c i d v a l i n e h i s t i d i n e. S e r i n e a n d y s i n e : 21 T h e p l a r o f t h e i o n i z a t i o n o f t h e i o l s r C O L P O r C Y S t e i n e i s 8. 33 So thi s a i.

oa. i a c O u i d s e r ve l s t h u f f e r i n t h e l S H a n g e f o r m s o V e r t h e p H r a n g e 7 1 3 3 3 3 3 The p a l l i n o f d u p s i d e , S p a l a g i n e a n d l y s . n e r a v e r y l a v a l u e S o f s i g n a d i n 9 5 ? r e S P e c t i v e l y ; t h e s e a r e a l s o p o s i b l e b u f f e r s ; b u t t h e y a l r e a d y t h r a t a f t e r o f t h e i b u f f e r.

an. s 12 a t p H 4 t h e c a r b o x y l s f o u r s i d e p r o t o n a t e d o a c r b o x y l a t e t h e s i d e c h a . n C a r b o x y l i s s t i l l p r o t o n a t e d t o a t a n a n d i o t h a n i n o s r o u p s a r e p r o t o n a t e d ; a t p H 7 t h e c a r b o x y l s r o u p s a n t , e s i d e c h a i n s o x y g e n a l l p r o t o n a t e d a n d t h e a c i d s a n d t h e o x y g e n t e a l l b o t h a m i n o s r o u p s a r e p r o t o n .

te. A t p H o t h e r t h e c a r b o x y l s r o u p s a t e s i d e c h a i n C a r b o , y l s r o u p a r e p r o t o n a t e d c a r b o x y l a t e o f t h e a m i n o s r o u p s p r i m a r i l y p r o t o n e a n d t h e e a i n s a l t . X t u r o f .

he. r o t o n a t e d a n d e p r o t o n a t e d o r p l a 2 3 t h e p r o t e r s t o t h e f o r m i n w h i c h t h e c a r b o x y l g r o u p s a r e d e p r o t o n a t e d a b o u t h a l f o f t h e g r o u p s p r o t o n a t e d a t p H 2 3 t h e p i r e . e r s t o t h e f o r m i n w h i c h O t h e c a r b o x y l s r o u p s a r e d e p r o t o n a t e d . p r o t o n a t e d a t p H 9 6 2 a t p H t h e c h a r g e a r o u p s a l t . b o t h a m i n o g r o u p s c a r b o x y l i n e a n . t h e t o t a l c h a r g e r o u p s a r t . r e t h e s a m e a s p H w i t h t h e a d d i t i o n o f t h e c a r b o x y l a t e g r o u p .

ec. te r m i n a l e u c i n e s i v i n g a t e t h a r g e o f 2 h e p e p t i d e s ; p h e n o g l u s e n e t i n a l t h e c a r b o x y l a t e o f t h e p r o t o n a t e d n t e r m i n a l a m i n o g r o u p . a t p H 7 , t h e p e p t i d e c o n t a i n s t h a s n o c h a r g e t h e c a r b o x y l a t e o f t h e p r o t o n a t e d N t e r m i n a .

am. f o s r o u p a n d t h e i o n i z e d t e r m i n , i c a r o x y l a t e r e l a t i v e c h a r g e T h e p e p t i d e o n t h e r f r a s h a n e t c h a r g e o f a t p H 7 . e c a u s e o f t h e s i d e c h a i n c a r b o x y l a t e s g r o u p o n t h e g l u t a m a t e i n a d d i t i o n t o t h e C h a r g e .

on. h e n t e r m i n a l a m i n o g r o u p s 2 6 i a d l y s i n e b e c l s t h e t h e s i d e c h a i n a m i n o g r o u p s o n t h e l y s i n e d u e o r t h e l a c k o r . S i d e c h a i n c a r b o x y l s o r s t i d i n e b e c a u s e o f t h e p e s e n .

eo. a t i t r a t a b l e s f o u p i n t h e s i d e c h a i n s o f a s p a r t a t e t h e c a r b o x y l t o n . t h e s i d e c h a i n 2 7 G l y c i n e i s t h e n e u t r a l s i d e b a s i s o f a b u f f e r i n g t h e C i d e n t i c a l . K o f i t s c a r b o x y l s r o u p o n e t h e s b o n d s : 3 1 3 1 w h a t i s t h e p e p .

ideß ond ? 2 8 seefi

sue. 3 9 2 9 T h e r e s o l u t i o n s t h e t r u c t u r e s o f t h e t r i b u t e t o t h e l a r r a r r a n g e m e n t b y s 6 C h a n g e p r e .

i. t F O l a i n g s f r o m s o u e n . e 3 5 T h i s i s v e i o l s e q u e n c e h o m o l o s y i a r s i n a i r o f t h e c o r r e s p o n d i n g p a r a l l e l f o l d i n g s . i t i s t h e t r y t h a t m e t h o d s b o t h e n t h e c o m p a r e t h e r e s u l t s . W i t h t h e s e o b t a i n e d f r o m h o t h e r e s e q u e n c e t o t h e 3 i s e.

t. e P r o t e i n t a r g e t 3 a p r o f i l e s a p o t e n t i a l i t y B β σ.

f. c t i o u s p r o t e i n f o l d i n g m u t i p l e . o f t h e f a m i l i e s ; o f t h e r e f o r e.

n. r a t e i n n e r i v o l s t i s s u e ; t h e r e i s a n o r m a l f o r m i n a b l e f o r m a l f o l d i n g a t e n d s t o f o r m p l a q u e s , d e s t r o y i n g t h e r v o u s t i s s u e . t h e y h a v e b e n r o u n d t h a t . t h e t r a n s m i s s i b l e a c r o s s s p e c i e s i 3 8 a s e r i e s o f t h e p h a l o p a t h i e s h a v e b e e n f o u n d t o b e c a u s e d b y t h e a l t e r e d p r i o n p r o t e i n . t h e d i s e a s e d a u s e d b y p r i o n s . s c a l e (d i) v i n e s p .

n. i f o r m e n c e h a l o p a t h y o r m o r e c o m m o n l y M a d C o w d i s e a s e s e l f s e e p f i s a i n a s e i s a l e d s c r a p i e l i m u m . n s i t i s c a n d b a k o r e u t z f e i d t - i s e a s e 3 9 t h e n o r m a l f o r m o f t h e P r i o n p r o t e i n h a s a h i s h e . h e l i x c o n t e n t c o m p a r e d t o t h e s u t r e a l n o r m a l o n e h a s a n i n c r e a s e d (4 7 w h a t s t h e e q u a l e n a l s t r u c t u r e o f p r o t e i n s ? 4 0 t h e r o t i c o l l a i n h e m e g r o u p ; o t h e r o x y g e n b i n d i n g s i t e s

u r u m u r o s o m e t h i n g w h i c .

w. 1 b o t h C H i s t e i n s o f t h e a m i n o a c i d s c a n t h e o r e t i c a l l y a t e d s , O W n e l o w . 0 1 0 0 5 m o l , 5 ÷ 0 0 0 5 m o l , s = 0 1 0 0 .

m. l e s t h i s t o 1 0 0 5 f o r t h e s o r t h e 0 0 2 f o r s n o w p l u s t h e s e v a l u e s i n t o h e n d e r s o n - h a s s e l b a l c h e q u a t i o n . t h e 3 + l o g c t r i s / t r i s H + 1 0 = g 3 + 1 0 g (0 0 2 / 0 0 0 8) p H 7 1 7 0 3 5 f i r s t c a l c u l a t e t h e m o l e s o f b u f f e r t h a t y o u h a v e . (w e a r e g o i n g t o s o l v e r o u n d i n g o f f t o m o l e s ; t h e l i t e r s a n d t h e l i t e r s o f T R I S , u f f e r i s o l u m e s i n c e t h e b u f f e r i s a t p H 7 7 o w e s a l i n e t i c e s o f t h e a m o u n t o f T R I S i n H + ; i s o . O O 2 m o l e s a n d t h e a m o u n t o f T R I S H + i s o . 0 0 8 m o l .

u. 1 1 b a d i n g , 0 3 m o l e s o f H + t h i s w i l l r e a c t a s h o w n T R I S + H + → H u t i l y o u r u n o u t o r s o m e t h i n g s . w i l l b e t h e T R I S ; i t s t h e l i m i t i n g r e a g e n t ; a l t h e r e i s c o n v e r t e d t o T R I S H + = 0 1 m o l e s T R I S = 0 1 e s t h e v e u s e d u p t h e b u f f e r a m o u n t o f T R I S i s t h e n o w h a v e t h e p r o x i m a t e l y a t H + i s l e f t o v e r s o m . i o n t h i s s p o k e n a t e l y 0 3 M H + p H = 1 . 3 P H = 0 . 5 2 3 6 t h e 1 f o r a r e a c i d t h a t h a s p K a t H + 1 2 = K a t H A l 2 1 0 s H + = p h a n d 0 8 C H A p H = 1 / 2 p K a n d 0 8 C H 3 7 U s e t h e H e n d e r s o n - h a s s e l b a l c h e q u a t i o n t o c a l c u l a t e t h e c r i t i c a l t e s t 3 1 3 8 ; t h e p K a 0 - 3 0 h a s a b u f f e r r a n g e o f 2 9 .

049 1 t W i l l n o t b u f f e r e f f e c t i v e l y a t p H 7 3 9 1 u s e t h e H e n d e r s o n - h a s s e l b a l c h e q u a t i o n . T h e r a t i o o f A w o u l d b e 3 8 1 1 0 1 l m a l l a s e s t e s u , t a b l e b u f f e r . a n c o v e r s a p H r a n g e o f p K a - 1 p H p K a c t i c a c i d , p K a = 3 8 6 a n d i t s s o d i u m .

sa. t p σ H 2 8 6 3 8 6 A c e t i c a c i d e p K a = 4 7 6) a n d i t s s o d i u m . a t p H 3 7 7 (T R I S c o n t a i n s p K a = 8 3) i n i t s p r o t o n a t e d f o r m a n d i t s f r e e a m i n e f o r m p H 7 8 9 1 3 H E P E s e t a .

le. σ p K a ? 5 o n l y t h e t e r i o f c a n d i t s a n i o n i c f o r m p H 4 5 5 . 8 7 5 4 1 s e v e r a l o f t h e b u f f e r s w o u l d b e s u i t a b l e M a l e i c s , H E P E S , M O P S , a n d P I P . σ S h o w e v e r t h e s t b u f f e r w o u l d b e M O P S a s i t s p K a i s c l o s e s t t o t h e d e s i r e d p H o f 7 1 3 1 . T h e s o l u t i o n i s c a l l e d 0 5 0 0 m o l a r , e v e n t h o u g h t h e c o n c e n t r a t i o n o f t h e f r e e b a s e f o r m .

he. o n l y u s e d a c i d s o l o r m w h i c h 0 5 o o t h e c o n c e n t r a t i o n t a t o n t o f e r t h e b u f f e r c o n c e n t r a t i o n s a r e Y p i c a l l y r e p o r t e d o f t h e s u m o f t h e t w o i o n i c 4 3 a t t h e o u i v a l e n c e p o i n t o f t h e t i t r a t i o n s m a l l a m o u n t o f a c e t i c a c i d r e m a i n s t h e c l u s e o f t .

e. q u i l i b r i u m c o o h - H + t h e r e i s a s m a l l b u t n o n z e r o a m o u n t o f a c e t i c a c i d 4 4 B u f f e r i n g c a p a c i t y i s a s s e s s e d a m o u n t s o f t h e a c i d a n d b a s e f o r m s . e a c h a d d s o f b u f f e r s e l l i n t h e b u f f e r s o l u t i o n a s o l u t i o n w i t h a l o w c o n c e n t r a t i o n i s c a p a c i t y i t h o n l y c o n t a i n s r e l a t i v e l y s m a l l a m o u n t s o f a c i d o r b a s e b e f o r e s h o w i n g c h a n g e s i n p H t h e p l e c o n c e n t r a t e d b u f f e r . t h e r e i s r e s i s t a n c e b u f f e r i n g c a p a c i t y t h a t t h e s e c o n d f f e r . l i s t e d h e a s i t u l e s b u f f e r i n g a r e c a p a c i t y t h e s e c o n d 1 6 5 i v i n g N H O n e a r t h e o u b l e c h a r g e . e n t 3 0 , l n a l i c a s e s t h e y i e l d 5 0 9 5 n f o r t h e s i d u e s t h a t w e l l n e s 6 0 % .

ie. d f o r s o r e s i l l .

s. % a n d f o r i o r e s , i d e s 1 0 1 6 9 t i e s e a r n o t s a . i s f a t o r , y i e l d s E

n z y m e s p e c i f i c i t y t s a r o u n d t h e p r o b l e m s i n t e r w o r e p t i d e s d i f f r i n a m i l a c i a s e , u e f c e h i t n o t i f i c o σ m p o m - 3 2 . T h e t i t r a t i o n c u r v e s o f t h e t w o p e p t i d e s w i t h a v e t h e s a m e . e n e r g i s h a p e o f t h e K a v σ a t l e s t , h e m l l i b a n i d a r b o X y l g r o u p s w i l l d i f f e r v i d e f u n w o r d i 1 s n o w s i s h t i f f e r e n c e s i n d e c h a i n p K a v a l u e s b e c a u s e o f t h e d i f f e r e n t a i s t a n c e s t o t h e c h a r g e d g r o u p s , t h e n d s o r t h e p e p t i d e s u t h e n d a n g e s a r e p a r t i c u l a r l y m a r k e d i n p e p t i d e s 1 3 3 i s p e c i a l .

he. e u m a s p a r t i c . e l l . s p e l l a s p a r t i c l e u p h e l i a s p , 4 D L F L - F F D L F L F D L F D 3 9 y o u . d g t 2 0 m l 2 7 x m o l e c u l e s ; t h i s g i v e s i t s t h o f t h e v o l u m e s i T , e s a e c l u s i o n f o r a p e n t a p e p t i d e s e v e n c o m p a r e d h e r e n s i n e s u i t s 3 t h e y a r e r e l a t i v e l y , s t a b l e b e l u s e t h e y a r e z w i t t e r i o n s ; t h e y c y p i c a l l y h a r e s a m e , i t i s p e p t i d e s 3 7 i t h v e r y l i t t l e d o u b t m o r e c o m p l e t e l y .

ng. h e p r o p e r t i e s o f w a f e r f r o m t h O s e o f t h y d r o s e p a r a t i o x y g n i n e i t h e r a t o r m o l e c u l a r f o r m o f o u r n e , t h e p r o p e r t i e s o f t h e p r o t e i n s o u l d i s h t b e a b l e t o d o t h e r e v e r s e s o m e x t e n d 3 . 1 t h e s e t w o p e p t i d e s s f r o m t h e c h e m i c a l l y . t h e o p e n c h a i n a t h e r e c h a n a d e t e r m i n a t i o n b u t t h e y c y c l i c p e p t i d e a l s o n l .

pe. t i d e 3 9 B o t h t h e c t e r m i n a l a n d t h e N t e r m i n a l o f t h e p e p t i d e n c h a i n p e p t i d e c a n t h e c h a r g e a t a p p r o p r i a t e p H v a l u e s . I n c h i s n t h e , s e l i t h t h e c y c l i c p e p t i d e , t h i s c a n r o v i d e l i a s i s f o r s e r a r a t i o n . y = 4 c a r b o x y l a t e s a r e n o t a s u r e c o n f e r e n i t r o s e i n e e d e f o r b i o s y n t h e s i s o r a m i n o a c i d s . 4 s u g g e s t t h a t y o u r f r i e n d s h o w t h e c a r b o x y l s r o u p s a c h a r g e c a r b o x y l a t e m o o m a n d t h e a m i n o g r o u p s p i t s c h a r g e .

or. c N H 3 + 4 2 t h e r e a r e v e r y f e w s i d e c h a i n s t . a t h a v e f u n c t i o n a l g r o u p s f o r m e 4 3 T h e r w i l l b e m a n y m o r e p o s s i b l e , o n e o r m i n a t i o n s t h e c a l s e o f t h e e r o t i t o n l r o u n d t .

ep. P t i d o n d 4 4 T h e t w o l i d b e n o r o s s i b i l i t y o f d i s u l f i d e c r o s s l i n k s t i t h i n o r e t w e e n t h e p e p t i d e c h a i n s ? s i v i n s m o r e p o s s i b i l e c o n f o r m a t i o n s ; t h e r e w o u l d n o t b e t h e p o s s i b i l i t y o f o x i d a t i o n r e d u c t i o n r e a c t i o n s i n v o l v i n g s u l f u r y l a n d - s u l f , d e s 0 u p s 4 5 T h e b i g d i f f e r e n c e w o u l d b e t h , 1 0 s s o f t e r e s p e c i f i c i t y i n t h e c o n f o r m - t i , o f a n y p e p t i d e . o r p r o t e i n t h i s w o u l d h a v e r a s t i c c o n s e q u e n c e s f o r t h e k i n d s o f r e a c t i o n s o f t h e p r o t e i n s 5 a n s a l l p e p t i d e s h a s i o n i c a l l y a c t i v e ? 4 6 O x y t o c i n h a s a n o n a p e p t i d e p o s s i t i o n 3 . n d a l u c i n e a t p o s i t i o n 8 ; i t s t i m u l a t e s s m o o t h m u s c l e c o n .

tr. c t i o n , n t h e u , t e r u s , r i n g , b o r n , i n t h e m a m m a r y g l a n d s a n d i n s t r a c t i o n . v a s o p r e s s i n ; h a s p h e n y l a l a n i n e a t p o s i t i o n 3 a n d a r g i n i n e a t p o s i t i o n 8 ; i t s t i m u l a t e s r e a b s o r p t i o n o f .

te. b y t h e k i d n e y s ; t h i s r a i s e s b l o o d 4 7 T h e r e q u i r e f o r t h e s u l f u r t h i o n e c o s i s t s o f t h e a m i n o a c i d s ; t h e s u l f h y d r y l g r o u p s t h e o x i d i z e d f o r m c o s i s t s o f s i m i l a r g l a s . l n d c a n b e c o n s i d e r e d t h e r e s u l t r o m i n k i n g t w o m o l e c u l e s o f r e d u c e d s l u t a t h i o n e b y a s u l f i d e b r i d g e 4 8 E n k e p h a l i n s a r e p e n t a p e p t i d e s , m o d e l F i l . ; l e u c i n e - k e p h a l i n a n d m e t h i o n i n e - e n k e p h a l i n s , w h i c h a r e n a t u r a l l y o c c u r r i n g a n a l g e s i c s 4 9 i n . o s t c a s e s t h e a m i n o a c i d s a r e t h e

4.3 What tiS thesecondaryStructure 0f Pr0teins? 15

S, aPe ,sol ubili t,anat ypeofbio lo gicalfunC tion(static, Structural versus dynamic,catalytic) 1 6 Theang leSofthe amide plane sa sthe Yrot ate abo ut the a Ca rbon The angles are both de fined as zero when the t WoPla ne s WOU ld be ov er lap ping.

UC, that the carbonylgroup Oforiec onta Cts the N Ho fthe other 17 Am- uige. Sa Co mmonforrepetiti ve irregularit yf Oundinan ti para llel sheets Amisaligment occurs bet weens trands, fthe Is heetcausingones idet0 bowout ward ls Are vers eturns aregion ofapol ypeptide whe ret he directio nchanges by abo ut 180 The rear- tWoking Sthosethatco.

ta. nprolinean dt hoSethatdo fo t se e Fig ure 4 6foreX. mples 1 9 Th eahelixisn 0t fullyextende d a ndi tsh yd rogenbo ndSa repar al le1 totheprot infibe rn T he repeatedse et Structure isalmostfu llYext ended a nd it S hydroge nbondsare perpendicular totheprotei nfibe 20 Th, da unitthe, abe uni t s th e b mander the Greeke yrtheha 2, I ThesecretptOf the pro li feresi duesuch thatitacesnot.

it, Ntoth each ti ixbu ti tdoesf, tExactly ora fever set Ums ce Figure 22, G lycine istheoni yr Si dues la ile to u shtOri tat- riCi, lfoin tsi flue io lla gent fi Ptielix 23 T, eri icip alcOllpotento fwo0 li SthePiptie like rati fo which, Sac rassi cea mpleO fhelicalstructure ThePro Ci paic omponelt ofsil kist heP ibeiis fi brOin, which is aclaS S cexalP eof theet Stru Cture The statements S0me thatofiDVe fsi Purificalti0n.

Ut, tisfurthe rental iv tri dl 24 00 whichconsist Sia r gerofthe prote, nk eratins hrilkSeCau se fibrobelica lcofro ma ti0n ti constre tcnall at tenshri Sil, c0ili s ttarsei vorth ePrO te i fibro Whic hasth erUui Ye xt ella lash ettconformation with farlessteuse.

CY,O st retcho fshrink 14 4 Whatcan eby ab0ut the ttodyn a mic- 0fPfo tein 251 ClainEre nb 0n ins v0l v ingth eC anditi0ns ft herept idech, in (2)sid eC hainmbo nls involving any, 0Sii hi Ch ydr0gen bo on d a dono roracc ptOf site, itec ra ins; (3)hydr oP h0bi c interactions in, 0i Vingt he hOlP, largroup s in the Prote in: (4)el ectro st ti cinter act i ons invol vin g a nyCharge d groups 0l the Prote in; (5)metal ligation.

i, Vo lvin g coo, di na tion b on dS b etw, eltsi decigi ngsalicone, a i0n 20 Stabili zati ofoftcEcffor mation, ere ofa fsolng owe ring.

fe, ergy? fe saralsss ortheri nformation involved Wi thsma lmol ec, lean te n Ct i ons tie ain CompoDe nto fene rgy fn anges is elt hpiciwi, hre ative ly s mall ent rofy changes in the Cas eof mo le cul esa sil ra fSPro tein, th enu merofrosS ibecon.

0r, ati ostakest le entrop, Cra p tof energic hangesmuc hm0rei mpor tant, his iS Par tic ular ly true intheca seo.

hY, r0Phobi c inter actions 4 Swhatis there ft iart's fdct or eorPr0t eins, 27 see fig ure4 for a hydr oge nbon d that is Par t of the h lix, ec mon d rist ructure seFig ure 4 13 f orthy drogen bon- tisPar t ort e rtiar structurcs Igiion, i nh ydr0gen bon d(ing, 28, S ce fig re 41 3fr elect r ostatic int era cti on s Sa S Sili ShOf Sh thisgen bet we enthesid ec hainSofl ysi nean asPar, a te 29 See Fig ure 4 1 3for an example of hydrophobicbonds 31 Ac lareir ofsir otei lhat ai dinth er P rotei nfir, lai nc0r re ct ly a nke ePsil, r0lls S 0 iat ingw th0, heP rot eins helieith as reached its fnar nlture form.

32, Conf ig u ratio fre er s to the Positi 0nofar ours due toco Varen tbonding Le xamp les in ll de Gandmi s ometrical to pical isomer ism Confo rmati ons refers t0t he Position inior group inspecdiet r0 tati on bout ing le bo nd, ne all rom ist pe differences, twere mere i sdal as, agere lc0 nfor rai, i0llsore th ane, 33 Fivie, Ssi ble pat re limit P ssib, proteinfo n fi gurat iolla nCon formati ons 1 ( )Alth, uhanYOne of2 ami, 0 aci dsi Pro ss ibleata, c h Positions on y0- eisusein ashi, tattedn the fers et hatcoders f0 rtha t Protei n(2) ist here are ma ny ma nDacato Ui bcEuse reatea, c hP0 Sitio f e xce Pro- sly g fe, tion lyL em,

n0, CidS ar euse d (,) ThePe Pti e-gr0 uPi sPla, ar S othal ton yian

ct

a, ra nge men tsar e observed The fals for 4 Sn0res tableand St e olfu Ulan-Follu, nPro tans (,)rh eans esalac ntemor rtical.

yt, ke0 naivy alu erol t03605 but0m ean sugar ent 0ssib, elec alsheors, eri Chi la rance: angist hatare, ter i cali-alno e ally notiv est abi lizing inter ctions, s0hes th0se inthe hel ix ( )Th e fin arystr uct ure de, efini tis amor tim Une rtia rystruc- uire a cOr ording to th e Se C0ntaliro the genet icO de 34 T, C hnic al ly, coli asent a squat ernary struct, ure be cau Se it h as multiPl eP ily Peptid e Chai ns, Owever most discussi0nsof qu atern- fys truct Ure i nvo lves ubu nits f glob u, arP roteins. for fibrous oles li kec0ll agen, Ysc ie ntists c0 lsider the c0nd sent tripl ehel i xtube ar ka, Pl 0 fase cond ar ySt ruct ure to 5 e 41 ua, umlbd e isulfate Oly acyl aid esel e te ctr0 Pro- esis, Wit hsoS PAGE t le Char le ndia red i ffering s0f Prot ei nsare lmilinate dsothatt hOn lyvariante fa etermining.

hei gra ti ons S the Size Of the Protein 35 SDS

bi, ds to the pro tei na con, tantr ati oofl4 S, ser g ra fP ot ein Itc0atsthe, rei nwi th nega.

iV, Cha rgeSa nPuts, t- n, ta rand on co i Ish, aP erm usch ar ge a nasn eart e limi nate.

61, narn lyac rya mide lu Seaforse r i intra ti Of hromatoof aPh y the ad

r

ar, Structur e is Primarily a helix Differences is attempt t wh il, hydrogbsolid samonol ers 0x ygen binding to em oglobin is c0 ope- ative, but m C00 per ative t0mbo sabin 41 T.

ec, Ucign res idesat Histidin esi n both Pro te ins 42 Ins hi she Side ytior 0r fanization is t el tiary lo g lob.

n , iSq uatern ary 43 T he func ti 0n of hel o gl0bin is oxyg n tra, SPor ti tSs iiko ida lbin dinifsur.

er, fectst he f act that tcl n in de as il, 00X, se n atc0, Par atives yhi h Pressures, n ne le as e0x yge nat ti0n erP, esS ures t herefinct, on0 mlly 0glohin is0xygelis tonasta sal res ult i t iseasilysa, tur ated Wit hoxy gen at low Pr ess ures As sh own by i ts hyPerbol ic ind ing curve 44 In thePles en c eofh nd CO 2 ,Pothof w hi C h bind to h emo

b, hb t hh 0xygen in,

in, CaP aci ty Ofhemo globin decreases 45 I In the abSen Ceo f 2 3 bisPhos Pho g lycerate t he bindin gof ox ygen by he mogl 0bin resem- es tha tofmyoglobin, cha ract, riz ed by a co0 Pe rati Vit y 2 3 bis Pho sP ho g lycer ate bi nds at t he cent erof the hem oglo binm olecule, inc re ase S coopera tivity sta bi lizes the d eoxyc, nfor, ati onof hemogl obin and0 dua tes the binding affinity.

eno tha tit cane asi ly be release

di, tH Car i ar ies 46 Fet alhemoglobin has oxygen ore strongly- han adul thema gl obi n s fetal 4 2 5 7 First a dultis 4 3 in na mcha in is P lace, bYa se li e mol eOX yg ented hemog lo bin is aWea k erac id, as a hi ghe r Pka than Oxyg enate dhem 0gl obin. In the w- ras de oxyhel t ed hemogl obin bin ds tot r ogen I Yt0H.

th, a0 e soXygen at each emo gl0b in The in din g0f H+ an d c0 2 to hemogl bi n at works hechanei fs uate s the structure t0t redox y en, ted for tofhemogl obi n the ti m ary raW in 0u rri en di gr eas oni n sare Ver sal of the definitio nto rp hemwhich is P, 1 0 1 t here is e Se Orbindi, fr Ydrose lin h emogl Ob iWere the Primary f actori nthe b ore, fec t the ch anges wol lde the h P positio n ofthe eo secit ull, Yobs e rved The P

0n, co he os 10 bi nto ca scent Phisthece ntra lPO in t the Phin cleas es t hearr e nomen cel tation dee sa sses, as tive ase ftra lsoft he c hlori as n isti dinet oase rine.

nthelchai nremove

sa, 0S itively Charged amino acid that could ra vei nteract e

d ith B Th US h.

re, refewersai tide St0bl

e, k, s0b in dissi tse a Siert hani tis i n 5 eif so nsti thick le cel tr a tha vesoles b normal, e lis i ob i n A th a shi ti tude S t he re is I ess 0x.

g n, ratheco n celt ration to f the deoxy form of the hemo rema glo bin increases le.

S, Ky en Canb0hy di usin g the, bserved brea thing diff cul ti eS 52 In retal neglob bin, the sbll hit, c0 P 0 Siti 0 n S 2 Withrep iac emcnt of the c hains bythe chai ns i Thisic, lie ce illustra tion a fect

St hechain 's 0th ethus, 0moz t ou S for the h s ha sno ruled in emog lobin 53 The re pti, e0x yem hf in its so, sox ygen t or e la lenty te feta plu rom the af ter.

a, hb 54 Bec ause eo P1 ewith, c kele, i i seaseat er.

n, cal yane m i C, s ome, ei l S Wi thf eta ihra Pr0du, ed toh ei Pove ro met heimpaired 0x ygen deli very Sys tem 55 The crys ta l interior melding ofthecau Seox yge, efit ertain u ther ove rsi Pi tain s fo rm Hae ox y hem og bin to hyhe m0g lobi n Chapters An ileis 5 How power, tha t opt ure rot, in sfr0 m Ce l ls? 1 Bi en and er Porter five in all so ni cat 0r 21 f youn ge ded to a int,

i, tres tructural integr it Of the Su Ce l l U la rorgan el les, aro tter me sinlo u de e tertein.

CallSeitis no rese nt le ne ti ssue s, Sicil, liv er thus th esoft e n 0if- tousel itchen is te vice ls Sa iti nsout, sap r0cess where by a h is hiyionisa, isll sedt 0red u f eth eS lu ilit y0 apro tei ninit i i itComeSollt0 S0luti0 nthe Ca lifbecentri, use cat hesa itr0, nifi0 d iP olecti0nsswi thie wate rinthe S0lu ti0n which Cilta, eS I ess water a vail abl etot he protein n o f Polar sitch ain s le s int0 in erac t betwe e n Pr 0 tei n mo leculesand they be c omd in- 0 lub le 4 T.

tira mi dici do nte nta l a rrangements a k S0me pr0 teins more soluble than oth ers AP, 0t ti ti v ti tm, rengt h, f0l ar amino aci ds on the Su rfac eWi t h the m0 re soluble t h an0 newith mo re hy d hP robic Ones 0n the surfa ce 15 H ydrophobic zat e l l ver, e i S using- aP 0t terlE with emo m ogen izers pi nthe homogen, t alsoo Kstosedi menthe un brokencel ls an d nuc lei i cellt rifuge th espelle ta n tad 5 0 0 0 Xs a fac o r I ect h er ed i t w i ch o nta i nsthe mit0ch ondri a 6 0 0 P,

6 To Xi Sone Sa nd ligt oc h0 nd ri ta ve o ve r la p fi ngs e di m ent al ati onch, l ade rist i0 n the re is n i ons, suc has uc0ge ra di e nt ce ntri fugatio n would haye t 0 e usedt 0s e ra te th e t y0 ra- e ll es f0 ll0w ing V 0n u e d i n co o lis se atures, ally m0re tan enoughto a l t urthe Pro tei n ra f to rthe, eat 9 Pri0 rdi s eas e s hay ebee nlinke d to thei mu fes,

s, emi itisbeli e e tha th e Prion Pr0t einf av e in te 1 ymPhs ys tel bo un at o 1, mP olicy tesa fa even tua lly derive at the nervo Usti, Sue w he rethe g i n to tra nsform the n ormal Prion.

0, eininto th atb to nllla 1 orr 1 10 while th e fe the Strong k ret i c Pr e dis Posi tionsto, a cquir esc, ar ie to ll.

al, re li 1 It causet hedi, e ase the di Se a S e ust he Sta rted by i n ges ti n g a Pri 0 n th t a t the ad y has, h eal ted to hor mati0n Prisc I I The Prot ein ffici ency t, 0 is anarh, a r fme a S ure ll e f o f the essentia la m i no aci ds n t o r n s i en,

YP, Of P r0 te in 1 2 E ssenti a l e ther i s essential 3 It ea mi no a cids tha t must be consumed, in the diet e a, se the b o o d C an not synthe size the m, ef ficient quantities 14 Reasons for predicti,

g, Ne ticall y m o difi ed food s in C r ea se, increasing t he i r Pr0 tei n Con te nt in creasing the i r s h elfl if e, in creas ingt h e i r resistance to inSect,

or t he rP e s tS, a n d i n c r e a s i n g t h e n e e d f o r e s t i c a d e s t o g r o w le.i ga ndthathasa hi ghe ra ffi ni tyf0 rtheb0un dPr o tei n th anthe sta tio nar yres in1 i.

an.doeslsaitisc he aPerb utle ssPe cifi c1 Asp eCifi C1 iga ndmayb. m0r eSPec ifichuti s Oftenexpen sive 11 4 A compoundc nbee 1ut dbyraisi ngthesalt conce ntratiOn0 rbyc hangi n gthepHSal ti sCh eaP, butitmightnotb. aSs pecifi cfora particularPrOtein Chan gin gthepHmaybe more sP eCi fi cforati-htPI range, bute Xtr emle sOfP Hmay1. Ode naturethe prot ein1 15 Rai Si ngthes a1 tCo ncentr.

ti.nis relati Ve1 Ysafe1 M ostpro teinsWi1 le 1utethi sway andst. 1 1 beacti V-inth ecas e0fan enzYme1 T h e Sa1 tcanbe re movedi1 aterviadia1 ys isi fnec eSs ary1 C ha ngi ngth eP HEn olght 0rem0 vethe- hargeca lc alls ethe prote in st0b ec0medena-ured1 Manyp r ote insa- en Ollbl eatthei Soelect ricpoi ntS1 16 1 T hebasis of m0St re sin siSagaro se, Ce11u1o se,de xtr an0rp01y. 17 SeeFig ure 5 17 1 18 wit hint hefractiona t i0nrange 0fa g e1f i ltratiOnc 01 Umn molecu leSwi1 1e1 utewith a 1i n ea fre1at.0 nSh iPOf10gM wV ersusth ei relutio nv01u mes1 aser i eS0 fSt andardsca n befun tos tandardiZeth ecolumn, a nd themaun kn owncan bedetermine dbymea Suri ngitse1 . tio nv01umea nd compari ngtoastan da rdcurve1 19 1 fot hproteinsWoU 1de 1utei nthe v oi dv0 1umetog ethera ndwouldnotb esepar ated1 20 Yes.

th. amy1asew ou1dCoeu ti nthe Voi dvol ume, b utth e BSA WOU1 dbe- nC1uded intheColu mn b eaU anldWo U1deutem 0res 10W1y 21 Set uPan anion exch.

ng. C01 Umn, sucha sQ se Pharose (qua te rna ryamine) Runth.

C0. Umnat pH8 5 a pH at w hichthePro tein xhasa n e tn egativech ar geP Uta he11ogenate contai ni n. Proteinxontheco1um n andwas hWi ththe st a -tingbuffe r proteinxwi11bin dtoth ec0 1u m n Thene1u te byrunni n ga sa1 tgradie nt 22 1 UsEaca tion exchangeC01umn, 1ike.

M. ePh arose a ndrunit at pH 6 p rote inxwi11hav ea positivecharg eandwi11sticktothec o1umn 23 Withaqua te rna ryamine,th eC o1u mnre- i na1waysha. a ltPOSi ti Vecha rge, andyou won thave to Worryabou.

th.P Hor Your bufferaltering the for mo fthecolumn W

it. a tertiar yamine, ther eisadi sso cia blehydrogen, and theresi nmay be positiv eorneutr. 11y chargeddep endingo n theb uffer pH 2 4 T heeasieSt wa Y Wou1db et ouseasucr oseg ra die n ts. Par atethe mitochond riafrom th-P e ro xisome Sfi rSt The rbreakOpe nthe mi tOChO ndr i aVi a hars hhom ogeniza ti 0n0 rSOnicat. on 1 centr ifugethe mitOChondr ia The pel.

et. OU1 dcontainpr ote i n B, Wh i , ethe superna t antC o nta i ne dproteinA containi nants cOU1dst i 11e x ist , butt he ycanb ecleanedaw ayby run ningel fi-t r at-O n , onse-h. dex G 5, whichwou 1dsePa rateCf romAand B and the nion eXchange chromat. gra phyon q s ephar0s eatpH 7 5 P roteinBW0u1dbe neutra1 andwou-de1ute, Whi le P rote-nA WOU1dSti. kt. tthecolumn 25 1 G1 Uta mi Caci dwi 11beelu te dfirst beCause theCo lu- mn PHisC1O setoits PI 1 Leuci nea nd1ysin ewi11bePo si tive1yC ha rge dandwi11sti Ckto.

he. O1um n T e1uteleucine, raise the pH to ar o und 6 1 To e1u tely Sine- la i sethe PH t oaround 11 1 26 1 Anonp o1ar am i no acids fa ste s t, So phenyla1ani n ewi11bethefirst t 0e1ute, f. 11o W edbyglycine andthenglutamic acid 27 1 The. ono1ara minoacids e1ut e, s1owest.

o1ara mino acidswi11 Sti ckthem ostto the sta tionary phase's. glu t amic acid wi 1 lmovethefastest, f011 owed by glycine and then phen y

1a.anine 28 1 A pro tein so1ution from ammonium sulfate pr epa rat i on i s pas Sed 0 ver a ge1 f-1tration c olumn where the pro teins of in te res t wi11e1utein the voidvo1 ume. Th.

sa. t, b eing very sma11, wi 11move t hroughth e columns 1ow1 y. In t his Way, the Proteins wi11 1ea ve th e Sa1t be hind and e xit th eCo 1umn w ithout i

th.13 What is e1e ctrophore sis? 29 1 Size, Sh ape, a nd cha rge 30 1 Agaros- a nd polyac.

1a.ide 31 1 P-1yacrylamide 32 1 DN A i s the molecule mos t often se p arated on aga rose. le Ctro Pho resis Although proteins ca n a1 So b e sep arated 33 1 Those with the highest charge/mass ratio would move the fastest. There are three variab leSto.

on.ider: Ca n a mo st e lectro ph0re Se S are do-e in a wa y to eli minate two of th e Va ri ab1eS s0 tha t t hes eP a. a tion is b-Size or bycharg e, b ut no t by both 1 2 5 31 Lineweaver-Burk graph: Vmax = 2.5 × 10-4 M/s, KM = 1.6 × 10-8 M 32 1. ee. raph: KM = 2 1 86 × 10-2 M concen tra ti Ons were not d ete rmi ned di r ectly by Absorba nce value.

we. e used inst ead as a ma tter of con Venienc e 3 3 1 se e gra p h: Vmax = 1 3 2 × 10-3 min-1, KM = 1, 23 × 10 3 M 34 1 The turnover number is 2 0 1 43 P-rmin u te 1 5 1 The number of mo1es of enzyme is 1 56 × 10 Turnover number = 1 0 7 00- e

C-1. 36 1 The 1ow KM fo r the aroma tica mi no acids i ndic ate s that they will be oxidized P referentia11y 37 1 It is easier to detect devi at ions of individ ua1.

Oi. ts from a stra ig ht line t han from a curve 38 1 The ass umpti on that th e KM is a- i -di cation of the bin di ngaffinity be twe en the substrate and the en zyme is valid when the rate of dissociation of the enzyme i Su bstr a te. Complex to produ ct and enzyme is much smaller than the r-t e of dissociation of the complex to enzyme and substr- t e 6 1 7 How do Enzymatic Reactions Respond to Inhibito-S ? 39 1 In the case of competitive inhibition the V alue o - K

M. while the V-1ue of K M remains unchanged in non competitive inhibition 40 A competitive inhibitor blocks binding, no t ca ta1y Si S 41 1 Anoncomp etitive inhibitor does not change the affinity of the en Zyme for its su bstra te 42 1 A com. etitive inhibitor binds to the active site of an enzy me, Pr eventing binding of the substrate 1 A n o ncompeti.

iV. inhibitor binds at a Site differe nt from the active site, c ausing a conf- rma tiona 1 ch an ge which re nders the acti V-site 1e s Sab1e to b ind Su b S t rate and convert it to Product 43 1 Com-e. i ti v e in hibi- i0 n can be overcom e by adding enough sub strate, but thi s is not tru- for a11 forms of enzyme inhi b -t i on 1 44 1 A Line w e -ver Burk P 1 0 -i s use fu 1 because it g -V es a strai ght line 1 It is easier to determ ine how we11 points fit to a straight 1ine than to a curve 1 45 1 In a Lin eweaver 1 B urkPlot for comp. t iti ve i nhib i tion th e li ne S intersect at the y axis intercept, which equals 1/Vmax 1 I na non competitive inhibition, the 1 ines are sh own b y the negative free energy change 1 The fac t that gl uc ose can be eliminated anaerobically 1 Here is a ref1 ection of the kinetic aspects of the re- action requiring over coming an act.

SC. ntr avel arou nd the beads, thereby ha v ing a shor ter path to trav el and elut in g a ster W ith e le ctrophoreSis the Prote ins are for ce d to go thro ugh the m at ri x, so they have lo res low ly if they a re bigger b ecause the r.

iS. 0re fric tion 3 7 1 The M wi s 3 7 , 000 d a1to ns 1 5 1 4H0 w Do we det e rmine the Pr i mary structure of a P ro tein? 38 1 The Edman degradation is 1 1 si ve.

he. de nti ty o f the N- termi nus i n its f i rs t cycle, sO do i ng. Se para t e expe- riment is not nece Ssary 1 39 1 It mi ght te 1 1 yo u if the pro t ein wa s pu re or i f th ere were s ubun its 1 40. 41 The am.

Un. Of Edma nr e agent must exa ctl y match the amo unt of N-termi ni in the firs tre actio n 1 f the r i st o n ly a little Edman re age nt s o me o f the N-te rmin

Wi. 1 not rea ct 1 If the rei S too much, s o me of t he sec o nd ami no aCi d wi1 1- reac t 1 In ei ther c ase, there wi 11 be a sma 11 a mo unt of c0 nt am inati ng P The rivat iv es 1 T his er. or g rows with the numb er of cyc1es run until the point tha.

tW. a mino acids a re re lea sed in eq-al amounts, an d you could not te 11 which one was supposed to be the correct one 1 2 1 In the fir.

tC. C 1e, the fi r st a nd seco nd am i no acid S f rom the N -t er. minal end wou1 d react and r eleased as PTH derivat ives 1 You wo uld get dou bl es i g nal an d no t kn o w which one was the t ru e 43 1 44 1 45 1 It i s possib1e th at your prot ein is n0t pure and needs a dditi onal purifica -O -Steps to a rrive at a si ngle polypep tide 1 It is a - So pos si b1e that the prote in has subuni ts, s o multi P le P.

1y. ePt ide chain S ould yi e ld i ng the c ont ra dic tory re sults 46 1 Th re are two fragments.

at. avec termi n i that are b1 ys ine or a rgi ni ne, whi ch is what tr Ypsin is- peci fic for 1 Norma 11 y, there would be on ly one fragm en tending wit h an amino aci d that wa s no t ar gi n ine or lysine, an d we wou1d immediately know that i t

Wa. the C-ter mi nus 1 His ti dine is a basi c Protein a1th ough it i s usua11y neu tral and therefore does not re act wi th trypsin 1 It is possible that in the pH en vironment of the reaction the histidine was pO si tive1y char ged and was re co gnized by tr y psin 1 47 1 It would tell you a re lati ve conce ntr ation of th e vari ous amin o ac ids 1 This is i mportant be cause it would help you plan your sequen.

in. expe riment better 1 For exampl e, if you had a pr otein whose compo sitio n showed no aromatic amino acids, it would be a waste of ti me to use a.

hy. 0 try Psin dige-tion 48 Cyan0 gen bromide would be useless as there i S n. methionine 1 Try ps in wou1d be 1ittle bet te ra s the pr0 tei n i S 35 % basi c re Sidu es 1 Try p si n wou1d shred the pro tein into over 30 pi e ces, whic h wo- 1

db. Very hard to analyze 49 1 chy

mo. try psin would b e a go od choice 1 The re a re more than four res i dues of ar- matic a mi no acids 1 Th e 1 0 Oa mino acid pro tein wou 1 d be cut fou r ti mes, pos si bly yie ldi ng nice fragm ents in the 20 30 a.

mi. oa cid length, Which can be Sequenced e ffec tive1y by the Edman de gra dation 50 1 It would work best if the basic r eSi due s were spread ou.

in.the protein 1 In that way, frag ments in the Propersi ze r ange w ould be gene- ated 1 If all four of the basic residues were in the fi rst te n amino ac id s, there would be one long fragment that cou ld not be se- Chapter 6 Answe- s 6 1 What makes enzymes such ef fective bi olo gi Ca l cat a lysts? 1 Enzymes a re man y old.

rSofllag ni tudemor

ee. fective Ca ta ly st S than a re nonenZy m a ti C. ata1ys t s 1 2 1 The majority of enzymes are proteins, but some cata1yt. C. NAS (ribozymes) ar e k no Wn 3 1 A b out Sec ond s 1 Year X 1 eve nt / 10 7 e vents x 365 da ys / Yea r x 24 hours day x 3600 seconds / hour = 3 15 Seconds 1 4 1 EnZy m-s h0 1d the substrate in fav orable Spatia1 0. iti ons , an d t hey bind e f fective1y t0 t he transitionstate to stabil- z e it 1 Note th at a1c o h o1 stays 1 ow e r the act ivati on energy, So t hi S . S no t a part ic u1 ar enzym e 6 1 2 W ha t is t he diff erence bet Wee n th e kin etic an d th e a sPecTs of reacti ons? 5 1 T here act i on o f gl- Cose with o xygen is th-r m o dyna mi cally f av o r ed, 13 7 1 If the pr ot ein we re ty to s olicion ce the cel1 s were broken open you coul d Ce nt.

fU. e at 10 O , 0o o X g, and all th e organel1es wo ul d be in the pe 11e t b y our e nzy me wO U

1. be in the supernatant, along with all the other cytoso li c ones 1 Iso late t he mitochond ria via differenti a1 or sucrose gradi en t cen tr i

f. gation 1 Use an other homogeniza ti on techniq u e combined With a strong d e

t. rge nt to release the enzyme fro m the m embrane 9 1 Ta ble Se xis t to tell you ho w many grams of ammonium sulfate (AS) to add to get a c. r. ai n per cent satu ration 1 A g oo d plan would be to take the ho mog enate and add en o ugh AS to yield a 2 0% satura ted s o1u t ion 1 Let the sample Sit- On 15 mi nute s on i ce and then cen tri fuge 1 S e pa rate the supernata nt from t he Preci pita te 1 Assay both for t he pro tein you are work i ng w ith 1 Add more A S.

0. he supernatant to ar ri ve at a 40% satu rated so 1uti on, and re pea t the pr o ce ss 1 In this way, you wi 11 f ind out what the p e rcent satur atio n i s needed to be to precipitate it 10 1 Reason ab1y harsh ho mo genization would be able to libera te th e soluble protei n x f rom the P e roxi s o mes which a.

e. rag i 1e1 cent rifugati on at 1 5 , 00 0 x g would sediment the mito ch ond ria (br o k en or i n t act) 1 The s up ernatant wou 1d then hav e p rotei n x but. n o pro te in y 1 Fre eze th aw tech niques and sonication wou1- accom p lish the same, hi gh, or th e mitoChondr ia and the Peroxi somes co u1d be se p arat e d in itia1ly by sucrose gradient centrifugation 51 2W.

at. S COlum n Chroma t ography 11 1 (a) size, (b) sp eci fic li ga nd b i n d ing abi l it y, (C) net charge 12 1 The largeS t p ro t e in se1 ute f ir st; the sma l1eSt e1u te.

as. 1 larger p ro tei nsare eXclud ed from the i nter i o r of th e ge1 b ead so they ha V e1ess a Vai1a b1e c. lum n spa ce to trave1. Es sen tia1ly, they trav e1 a sh o rter dist anc e a nd e1 ute first 13 1 A Co m

PO. und can be e1u ted by rai sing the sa lt co nc-ntration or by adding am briu F orExall PIe'if-Misanal 1OS teficacti atoro fsi yco-enphO Sp hory lase theimm ediatei nc rea Se iNAMP whenMuscle sc Ontra-tcanC ausemu-clephOsP hor. lase tob ecomemore activea ndpr ovideen e rgyfo rth eco ntra Ctingmusc les The Ph.S lati one ffecte. Uite sthehorbon ecasca debeg in ning with glUca go norepine Phrine, Therear emanysteps before theth glycoge nphOsP horyla sei sPhosph Ofyl ate d, s otherespo.

se. i m eissiower Howeve th ecaSca de effeCt Produ ceSm. nymo rea ctiVatedpho SPh ory 1ase mOle cules, s 0th eef fecTs are 10ng efand d 2 2lasP arto. the mech anism, the sodiUm potass iUm ATPaSe hasaNaspa rtat ere si duethatbeco mesphos. hOr Ylated This P hosPho ryl at ionalter Sth e Conf-rmat ionofthe enzy me andcau se sitto c los eOnon es i deofthe me mbr aneand OPE non theo th er, movi ngi onSint he Pro cESS 2. Glyc oge nPhos PhOr y 1as ei s con troll-dall 0s ter icaUy by Severalm ol ecu les Inth.

mu.C 1e, A Mp i Sa nd 1 0

St. r i cactiv at on Inthel i ve r, glucoSeisa nall o stericin hibitor Glycogenp h OsPhoryla seis ex ist sing phoSph of yla ted for mandanun Phos pho rylatedf orm, . i ththeP hos Phor ylatedfo rmbe in gmoreac.

iV. 7 4 Wha tarezy mogens, and Howdo they controlE.Zyme 24 Th edi-e Sti vee nzym es tryPs inandChym ot ryp sina re cla Ssicexa mP les o f reg Ul ationbyZ.

mO. ens The blO od Cl otti ng p rotein thrOm binisa noth en 25 Try pS in, Chymot ryP sin, andt hrom bin area1 IP rot eas es Trypsi nC lea ves pe pt ide b Onds where. he rearam i noaci dS Wit h posi tiv e 1y charge dside chain. (Lys andAr g) C hymo tryPs in c leave sP ep tide sa tamino acid s With a. Oma ticside Cha ins Thrombin c1eaV esth e protei nfibri no gen int 0fi brin 26 Thezy mOge npro th rOm binisc lea. edto giveth eactiv eenZy me thrOm bin Thethr-mbin thenc leav es aso1 ublem olec ule, fi b β-i nO gen into a nins.

lu. le m O1e Cule, fi br i n Fibri nisa Pro te in that forms partof th eblOo dclo t 2 7 C α-ymOtryp si nOg enisa n β-nactivezymoge. Itis acte-uPOn by t ryPS i nW h ich cle aVe s PePtides atb asicresid ue s 1 α- eatg inine when tr. β-sil cleaveS bet wee nthearg i ni eandth eisol-Ucile, Chym o trypsi n-gen, ec o mes emi. Cti ve f Orm ilg This mOlec ule di ge S ts itselffurth er, formingth eact i ve chym otr β -Sin Asi t. Unlso it, t he a mi noprou p of the iS oleu Ci ne Pr od uced by the first cl. avage isnea rt heactive si te of the mOtryps in a nd nece ssa r yfo ritsacti vit 28 zy mOge nsare 0f te n e new ithd. gesti ve en Zyme stha re pro du ced in o ne tissue a nd us ed i nanoth e r, If then.

ym. We reactive i mmedi at e1 yuP ONP r OdU Ction, it wou1d i ge s t othe-cell protei ns where it wOuld cause gr e at d amage By havi n g it pro-duce das a zym og en it can b e sa fe1 ymade and then transpor.

ed. Othed i ges tive tissue, SUC hasthe stom ach or small in testi ne,-here, t Can thenbea Ct iVat e d 29 Th is a11 ow S f or am Or e raP id response when the hormon eis ne eded The ho rm On eis already sYnthes iZed and usually j u st r e quires break ing On e Ortwo bo. ds tomake ita ctive The hormon ecan be poised a nd ready to go o nd em and 7 5H OWD OAC tive Site ev ents of all E nzyme af fe Ct th eRE actio n 30 Isefine and

histi dinear eth etwo mOs tcritic a1 am inoa Ci dSi nthe ac ti ves-teof c hymo trypsin 31 The in itial phas-releasest hefi rSt Pr oductan d iW 0 lves ana cyl en zYme inte rmedia te, This st episfas te rth ant

es. C On d P ar t where w a ter comesin tot he a Cti v es ite

an. br eaks thee nzymea cyl bond 32, Inthefirst Step oft h e reaction, these r in e hydroxy l is the nu Cleophi le that at t ack s thesubstr at e peptide bon

I I. thesecon d step, water isthenu c leophi le that attac ks the acyl e nzyme interme d iate 33 His57Pe rfO rm sas eries.

fS. ePs invo lving gener al bas ecata lys is fo llowed by gener al acid ca. aly sis Inthe fi rst phase, i t tak esah ydr Ogenfrom s

95. acti ng as a g eneral b ase This is f O1 l 0 w edimme dia tely by an ac idCat aly Si s step wher e it gi ve st he hyd rog e n tot he all i degr oup Of th e Pe ptid ebo nd th a t is b e aki ng. A Si mi la r Sc h eme take Place i n the Se co nd phas e of the r eaction 34 . he fi rst P hase i S f aster f Or se ve ra l reasons The Serin e a t POs ition intersect. tth ex axiSi nt erCept w hich i s equ a1 to 46 K M =7 42m M = vmaX =15 9m mo1min-1. nonc om Petiti veinhi bi tion 7 Co mpeti ti vei-hibiti o n, KM=6 5X 104 The keY Point.

re. St hat the Vmax i s the s a me wi th i nt h e limi tS o fer r0r, some of the c0 n c entrat i0ns are gi vent (b.e. gnific an t fi gure) 48 , ti s very goo d in the c ase of non compet i tive in hi b it ors; Muc h 0f met abo lic Cont r01 de pend s O n fe e d back inhibi t. On by d o wnstream non com peti-i vei nh i bit O rs T he question, spe r haps notin t he case of c OmPet i ti Vei nhi bi tors, w hich are mu ch. ESS co mmonly e nco unte red i nviv0 Some anti bi0 tics, howe ver, a re com peti ti Vei nh.

bi. 0 fsc goo d for the Si c k person but ad f0 r the bacteria) 49 B ot h these lo ea nd the i nte rCe pts wil 1 cha. g e The l ine Swi ll intersect ab 0 ve the x axis a t ne gat i ve Va lues of 1 / S 50 Not a11 A I Ds drug s are enzyme i nhi bi tors, but a n imp ort ant C la Ss 0f s uch dru gs inhibi t s the HIV prot ea se Youwou l d need t. Und erstand the con cep-s of subst ra te b in di ng in hibition, and i nhi bi t0 r bi nd i ng 1 An irrever si ble i nhi bi t Or is bo und by co v alent bo nd S. No nCovalent-interac tion s are r e lat i ve ly wea k.

nd. aSi ly b ok en 52 A non com Pe t i ti Vein hi bi tor d Oe Sno t bi nd t oth eactiveS it e Of anenzyme I tsstr. Ctur e nee d be a r no re 1ation to that of the Substra.

ec. apter 7 Answers 7 1 Do es the Mic ha eli S Menten M odel Des cr ibe the Beh avi Or of A l l os α-ef iC En zYmes? 1 A l 10 s teric En z ymes disp lay sigmoidal k in eti cs Wh en r at e s are. 10t ted ver Su s su-Strat ec onc entr ati On Mi Ch a e lis Men ten enzyme Se xhibith

pe. boli ck i n e t i CS All osteric e nZy mes usua11y ha Ve multi P le su-unit s, and t. e binding o f Su bSt rate s Or effecto r mo1ec. 1es to one Subunit cha nges the bi ndi ng be havio r of the Others.

bl. its 2 Iti Sa nenzyme uS ed int he ea r1 y stages of cY tidine n ucleO tide Syn thesis 3 ATP act s as a pos. ti ve effector of ATCas ean dc TP acts as a n i 4 The termKMshou ld be used fo r enzym es th at di spla y M ichae lis Me nten kin.

One ne rg Y ba rri er 61 First

qu. S ti O n Mostp r0 b ably, 10ca1 c0 ncent rati onsm assact i Oncon ce pts >collid eas i ly di c ta te thedi rec. i on S eCond qu es tiOn, p rob-ab1 y no t; 10 Ca1c on centrati o ns would se1 d om be Suf fici ent to ov er c Ome are lative1. la rge u of 5 3 kcal in the reverser ea ction .

se. , h o WeV er, the a ld 01 ase reacti On i n glyC o1ysi s) 7 Heating a p ro tein denatur es it En zym atica Cti vity deP endsonth e Corr ect three dimensi Ona l str uCture of the prote in The Pr esence of bo und su bstratec an make theProt.

in. ar d er to de na ture 8 There Su lts do not prov e tha t the mec hanis m i S correct b ec ause resu lts from di fferent ex pe ri m ents co uld contrad ict the Pro posed mechanis m that ca se, the mec.

an. S m Wou ld hav e to be modi fi ed t O accommod

at. the new experim ental results 9 The Pres enceofaC atalys ta ffe-ts thera te Of a reactio n The sta n dard free ene rgy c han. e is a ther mody nami c pro p erty that does n Ot depe nd on the reac tion rat e, conS e quently, the p res ence Of the cata ly st has no effect 1 on the P.

se. Ceof a Cata lyst10wer s t he a ctiva tione nergy of a reaction 11 E nZy mes, 1 i ke a l l c atalysts, nCre a se the rate of the forward and r-verser ea ctiO n tOthe Sa me exte nt 12 The a mountof pr oduct o bta i ned in are aC ti on depends on. he equilibrium co ns tan t, a Ca ta lys-do e s not a ffe ct that 6 13 How Can we Describe Enzy me k i net i cs Math.

ma. ical 13 The reac tion is f i-S t order wi th re sP ect to A, fi r st order with respe c t to B, and se c ond order o vera ll The detail ed mech a nis m of t he rea ct i o n is likely to i n vol ve o ne m olecu le ea ch of A and B 14 T he easiest way to f01 low the ra te of this re a cti on is to mon i tor the d.

cr. aSe in abso rbance at 34 0 nm, re fl eCt ing the d is a p pea rance of NADH 5 Th e use o f a pH m et er wou1d n ot be a good way t o monit o r the ra te Of the r eacti on.

YO. are Prob ably runni n-t his reacti On i n a buffe r so1 ut i on t O kee p the pH- eiati ve1y const ant If you a re n 0t runn ing the re acti On i n a buffer sO 1u ti O n, yo ur un t he r isk of ac id dena tura tion of t he en zyme 1 1 6 En zymes.

en. t O have fai rl-Sharp pH O Ptimum va lues

I I. i Sn e ces Sa ry t0 en sure th at t he pH o f the react ion mixtu. e stays a t the O Pt i mum val ue This iS e sp ecia lly tr ue for rea cti Ons th at re quire or pro d uce hydrogen. 0ns 16 4 HOW D o S ubS tr ates Bind t o Enzy me S? 17 In the loC k an d key mode 1, thes ubstr ate fits into a comparative1 y ri gi d p r0tei n that has an act i ve si te with a We ll d. fi ne d shape In th e ind uCe d fi t mod e1, the enzyme U nd ergoes a con formation a l cha ng e on b in di n g to substrate, The ac ti ve si te t ak es sha pe ar ound the Sub strate, 18 19 The ES complex wo u ld be in a n en ergy t r0 ugh, With a.

On. e quent ia ll y larg e act i Vat i on energy to the t ran Siti On sta te 20 Ami nO ac ids tha t are fa r a pa r t in the ami no a cids equ enc e ca n be c lose to ea ch ot her in th ree di m ensio ns bec a use 0 f p r0tein fo ld i ng The cri tic a1 a mino acids are in t he acti V es ite 21 Th e ove r all Pr. tei n str uC ture i s ne eded t o ens ure the correct a

ra. gemen to fam i no acids in the a C

ti. eSi te 22 Thes tro ng inhibiti on i ndicates ti g htbind i n g to the aC ti V esi te Th u s, the Compo und is very likely to be a tra nsi-io n st ate analogue 6 5 What are some Exam ples of E nzy me Cat alyz-d Reaction S? 23 se e Figu r es 6 6 an d 6 7 2 4 No tal l enzy mes-0 1 10 W Mich ae lis Ment en k ineti cs The kinet i C b ehavior o f a l 1 0st eri c. en zy me s do e s no t obe Y t he Mi ch ae l is Me nte n equat i on 2-The graph of rate a.

ai. St Su bstrat ec once ntra ti o ni S sigmoid a l for a nal 1 oste ri c enzy me bu t hyp erb 0 li c for all.

nz. me th a t obe Ys the Michaelis M-nten equ ation 6 6 what

IS. h e Mi Chae lis M en te n appr oach t o Enzy me K in etics? 26 The reacti 0n ve1oC i ty rema ins the same wit h incr. a s ing enzyme co-Centrat i on It i S theoretica l1 y Po ssi ble, bu t hi ghly un like ly f0 r a r eac tion to b e sa tu ra ted Wi t h en zyme 27 The Ste ady sta te ass u mpt i On is that the con ce ntratio n o f the Sub Strat e comp lex d oe s not change a ppreciabl y O ver the ti me in Whi C h th e expe riment takes place The rat e of a pp ear ance of the c omplex i s se t equa1 to i ts ra te o f di s appearance, si mpli fy i ng the e

qu. ti ons f or en zyme ki ne tics 28 Turn Over nu mber = Vmax / [E]T 29 US. Eq uati on 6 11 6 (a) V = 0 5 vmax; (b) V = 0 3 3 Vm a x; (c) V = 0 09 Vmax ; (d) V = 0 6 Vmax; (e) V = 0 91 Vmax 3 0 See graph: Vm ax = 0 68 m M min-1, KM = 0 421 M 14 5 b uti t di dbi nd t O C TP and ATP 7 2 W hat ar. the Mode ls fo r the Beh avi or of A l l 0s teri C En.

me. ?1 4 In the Conc erted mo del, al l the s ubunits in an al l

OS. e ric e nzy me are f ound in the sa me form, either the T or the R They are in equ i li br iu m with eac. enzym e h aVi ng a ch aracteri stic rat io of the T / R In the sequent i al model, the Subunit s cha nge in di vid ua ll y from T to R 15 The seq uen tial mode l ca n exp l ain neg-ti ve coop erati v. ty be cause s ubst ra te bi nding to T for m Could induce other s ubu nits t o s W itc h to t he T for m, the re by r ed uci ng bin din g affinity 16 Great er.

co. era ti Vi t y i s favored by h a vin g a hi gher ra tio of the T/R f0 rm. It is al so favor.

bY. avi ng a high erd issociati onc. nsta n t for t he substr a te b in din g to t he T f orm 17 T he L valu e is the e quil ibr ium ratio of. he T/R fo rm The c valu e is t he ra tio of t he dissoc i ation c0 nstan ts fo r substrate an d th e tw 0 for ms of en zyme, such that c = K R/KT 18 Ma-y mode ls are p. ss ib l e When ever r ea lly kno w fo r sure how the en zym e works, rat her we cre ate a m ode l that e xpla ins the obs er ved b eha vi on It is very p ossible t hat no the model wou. d do so as we ll 7 3 How Doe s phospho ryla t ion of spec ifi c Re s idu es R egu late 19 A ki n ase is a n en zyme t hat phos phoryl ates a pr. te in usi n g a hi gh e ne rg y pho sphate, such as ATP, as the ph os phate do nor 2 0 serine, threoni ne, and ty r0 si ne are t he three m. S to ften phos pho r y la ted a mi no aci ds in pr0te in s that are ac te d up on by ki n ases As Part. this ano t her One of te n phos p horylat ed 2 1 The al losteri c ef fec t can be f ast er be ca use it is based on si mple binding eq.

te. Int Hsec Ond Phase, wat eri s the, uc leoPh i l e a ndi t akesti mef ofwa ter todif fuse to the rig his 0 tto Per ormits nu. Itop, i licatta ce I ti ls0 Rodss trolsacturo t l i dath ese ri nel lte eforeitake siolger forwater to Perform its fucle OPh.

li. atta- kaflab reakth.

ac. Ienzymei n termea iat th ani takes forse finetoc reat e it 35 Hiss7eX i sS i lbo tht heproton. tedA n duapro tonat efro fmdu r inst heCh n0try S il react i o l Ispk lO r 6 0 NuKst hisP Ossib- ei lth. PhySio l oRC alpHa ng 0 36 l n s te a d r a P r e l Y la nfli ne moie tussin ilartothe usl ai sub st rate s or chymotrypS. n0 useanitr oselmconta ini ng ba Sic gr ou p simi lar to the Sua i s ubst r ateS ofttrpsi n 7. 6 watTyPe Sffc hemicalre acti0ns are lnv0 l vedi l nzyme 37 The Yact a slewi sacidsce. e ctr onpa ir accep- Ors and cannake artifenzymatic a isme C anism s ofen.

yM.Si 3s Fai Se In echanis msore nz ymati Ccataly s isa

et.eSa measth os ten coint ere d i n ord, icchelis Str y 0 ler ating il aCo PleX = 39 . ene ranci c iC ally sis is theplrtor nf nzymeec.

an.S mw rea fa mi nacid Oro ther mbie cu led Onate Sh

0g. nio nto nother molecule 40 is Ni st ansf o rni b ecNa mu CleoPhilic Subst itution heu fu m 0 lmecul, ma tm ean Snatit obe ysfirs morderJi gti cs lrthre. Cti 0ni se X +Z: R: Z+X: W it lat Nl reac tion, therate isdep en de nto nthe Sre e quiltlhicht hexe. ksaW a from the Thez s f00lco mesinta. e anu ui ckito Com Pared totheb leakdowl off X sN 2 stan, S for hi m 0 l e- Ula r nuc leophi li C sub stitution Shanpensik hthe a mer eac ti onschem ei rthez a t ack s thel x m 0 l ecu l e ber o rei.

breaksd OWN Thust

le.0 nCen tra tionorbO

t. Ri xa nd are impo rta nt and t hera ted. Sp lays secon dao of er m-41 Thesy e- ctionlea ast oi 0 s 0 rs te reo spe- ifi ci ty a.

t. eX gro u ea ve s f er or the ether i nuile.

Phile r hism ta nSt thathen ucre i0 rh lecane n te r r rul r fe efte

a

ng les l ealing to d if fe ren tis 0 ers 42 Th er esul s d on t pr 0 tet

h

att hentcha m Si Sco r re C tec a use r esul t sfr 0 m if fere nt exte mi me fsco ll acO ntlaict.

e. rop osta ecani Smi nt l atca se, the ti c Ha n i snwo lu ahave to tem 0di imfi ca t0a cc omm oda te there e Xpe r i mentair esults 7 47 wh. ISthe cone cetli n e twe e rea Cti ve Site an d tran Sit ion 43 AOod tf ansiti onstate ala lo sl e wo lu diav etonlVe a te.

r. hed raca rionatom th e re thalli decario ny 1gr0up a s 0r ali nalyfo und Ssincet t rarsiti onst ateilV olve sall.

m. nt a ry tetra hedra i f0 mi tivol ica lsolon av e t0 ha ve 0 lysens 0 n the Sant cab onS ot athe te0 uiel is5uf Ficent Spe Cif icit y fo r t e acti. es ite 4 Theind uce d fit0 d els 5 ume St a the enzy me ands ibs trat emu.

t.0th e ls the Cn e lhac han Seto c0 f or nto eci Choth erpe rec t, yi thu St ie tnleri tis fou b et wee.

t. ee ll ymean s u sb strate but betwee ith e ehzy le-nthe t ra nsi tionstat eorthe substr. te0 ni s wayt0 Prod uctatra n siti onsta teanl ogs uew il i fit th en zymenice, Yinthi Smolekn sw Er storr oblemsc.

a. tera ls we rs ulthatar. theB asicme, es r0 rr hisle xp i apo lyme risive ry la rge lo ted, efom ed by i k ing small eru nits cm0 forme rs)toget. er Ar or Crini sapoly, erformedb y linki n gsami noac.

d. tos ethe n Aluc eica ci d isap 0 lym efforNe dby ii nki ngnucleo tidese ether ic ata ysis. the pro ce ss thati ncreasesthe rat e0 r ch e mica l re ctions 0m rel t o th e nca t a lyze dre ctio. Bi0 l 0g icalca taly S ts a re pr otei ns ca l le d s ta l ysts; the o eX cep tion sa rea re w iposor RNA whi chlunc ta lyz esome of the rta c ti onsorthe ir o nmetab ol i.

m. hetero t dis the nal bby whi chthei n fo mation forth es tru ctural of t hei onor ailli nflst hi ns is Passedf, mon sene rti On to t her ea These nuc eo pu rin e and Py rimidines i n D NA ca r r est hestrr. et 0 de (RN is th e c odingma te rial i s0 m. ri nes a re es) i 2wattsthe chemica ina turef 0 fl p r an. Bi 0 m 0 lecul es 2 The c ff ec tma tCh Off i n tioorga ni 0u is ala Conf ou l, C0nta in ing tha t fiull tiOnal pu i siaVe n i nther.

11. W i n gis t a min gro u pcH3 cH 2 NH 2ca r b nyl gro lp ketofe) c H3C ocH3 H ar. XY i gro ucH3 oH carb 0 Xy l gro u pc H3c00H ca rb 0 nyl gr 0 up (aldehy de) cH3cH2c.

0T, i0 lgr 0ucH3 sHs tertini k a secH 3 c00 cH2 cH3 p 0u ble b on di CH. cHc HcH3 Alde li n ka secH 3 0Nc. H3 >2 et le rcH 3 cH2 0cH 2cH 33 Th fulc ti onal gr ou psin theco mpoun ds o f 1 0 W: 4 le r o re 1 8 s, theco.

ce. t0r Vital ismrelat iator sani c0 m r0u nds coul do nlybe made b

Y

li. i nsy stesa nwere bey ond the r ea imof lab0rator ynveS tiga ti o ns in ohl. s yn th esi SSh 0 edt hat o r sanic c0m, u nds i kein orsa nicon es, d ia nl 0t requi reav i tal ist ice la nnanti o n = u nd the rthe.

0b. Yed the ia ws o r chemist ry ar a rh ysical l thus we r, subjec t 0 lab ora to ryi fe, tig a ti on s u se nequently, ke conce r tase xtend ed 0t h em ical mor leom ple xb i stin te sted i s c an Pl ile 0 thi oct i sry 5. Ur a i ke a 110 ranic co mpou nds, s hd st hesam e m0 lec lurs tru cture w, et her iti. Pl 0d uced by a livin so r san, smfl o n 6.7 le ive7i ft ht W c yclophe fa re d eri vatives. ta nl nucleus T hirte ndi ffer entalo, 0 lsy ia lde hydes/ ketone s an d noe a Ch ep oxides a d et ers 1 Bth at can Bi ochem.

St. Y Sa ya bo ut oss ibeo r igins of Life?

9.t isne hen ne i eve d tha tc arb nis thei re ly ba s i s f ora lli f e r ms) ea rt h c u nd e x t ra t e r e s tria 1 l i 1 o i is ht e e- r si ar iS 0ulasi l ve 2018.

12. 6X10 25 0S Sibi litiest th.

Si. res ults w i ll ie dic e necessary to have tea SAV0 s a d ro snu. be r c 022 10 3 of Possi bi lities hi then uther is 440 fi i 2 X1024 whi. his thice a og s a d ro s nulie n 1 2 R Na i sca la bi eo fboth CO.

i n a nac ata l ysis 3 ica ta lysi sa now s 1

iV. n sor a nisms to car ry out ch emical reactio ns muc h m0 r e e r fi cie nt

lT his,it is n0t used with lo Stenzyme sy techn i ca l.

y, om poti, i Vean dno ndllr eti tivei nhibit 0n a r sis0 t ei nst hata r tres tr i c ta t 0 mi chel is wte re n zymes, a tho ught e C 0n c e t sa rea PP i cabl et a ll enzyme Is ali nhibi t o f tha t b na s t o sp m i lart os tere c.

nz. mea tth esa l esi tea s th s u b strate issimi lartoa c a s i c a i C 0 mPeti tive. nhibi t 0r 1 0 netqu i tl n c S at a d i f fer ent s i t e s s i mi lar to a l n c o m p e ti tiveinhi bi tor y butthe C l l ati onsandthe graphsch aracteris tic o f c o m P e ti ti v e and.

0n. 0mPe titi ve inhibi, i0n, tw0, kth esa m, tawi th ana l o gs te ri ce i Zy te s r a k s t e m i s a l l o s t e r i c e n z y m e i n h i b i t i o n c h t h e i l d in o f i n h i b i t o r l a r t . I s t h e a p r a r e n t s u b s t r a t e co n c e n t r a t i o n n e e d e d t o r e , c h 0 n e m a i f V m a x 0 A V s y s t e m i s a l l o s t e r i c e n z y m e i n w h i c h t h e b i n d i n g o f i n h i b i t o r s c a u s e t h e e n z y m e t o b e t u r n e d s 0 h o m o t r o p i c e f f e c t s a r e a l l o s t e r i c i n t e r a c t i o n s t h a t o c c u r w h e n s e v e r a l i d e n t i c a l m o l e c u l e s a r e b o u n d t o a p r o t e-

n

l T. ebi nd i ng of substratetoo ne c u l e s t o d i f f e r e n t s i t e s o n a n e n z y m e . S u c h a s t h e b i n d i n g o f a s u b s t r a t e t o A T c a s e , i s a r i c a , p i 0 r a h 0 m o t r o p i c e f f e c t . H e t e r o t r o p i c e f f e c t s a r e a l l o s t e r i c i n t e r a c t i o n s t h a t o c c u r w h e n d i f f e r e n t s u b s t a n c e s s u c h a s i n h i b i t o r a n d s u b s t r a t e b i n d t o t h e p r o t e i n I n t h e A T C a s e r e a c t i o n s i n h i b i t i o n b y C T, a n a c t i v a t i o n b y A T P a r e b o t h h e t e r o t r o p i c e f f e c t s s i A T C a s e s m a y u p o r t w o d i f f e r e n t t y p e s o f s u b u n i t s (h e o f u e i s t h e c a t a l y t i c s u b u n i t a n d t h e r e a r e s i x o f t h .

m0. s a n i z e d i n t o t w o t r i m e r s . T h e o t h e r s t r u c t u r e s a r e r e g u l a t o r y s u b u n i t s w h i c h a r e o r g a n i z e d i n t o t h r e e d i m e r s t h a t e x h i b i t c o o p e r a t i v i t y a n d t h o s e t h a t r e g u l a t i o n . T h e r o l e o f s u b s t r a t e c o n c e n t r a t i o n . T h e i r c u r v e s a r e s i g m o i d a l . T h e v . 1 0 r C o o p e r a t i v i t y c a n t h e s e e f f e c t s h a p e o f t h e s h a p e o f t h e c .

lV. m0re s i s m o i d a l 1 1 A c t i v a t o r s a n d t h e S h a

pe. f t h e c u r v e l e s s s i g m o i d a l 1 2 K i s t h e s u b s t r a t e c o n c e n t r a t i o n t h a t . e a d s t o h a l f o f t h e m a x i m a l . 1 0 c i t y t h i s t e r m i s u s e d w i t h a l l o s t e r i c e n z y m e s i n t h e t e r m K m s m o t a . P r o p i a t e 1 3 a l l e r c u r y c o m p o u n d w a s u s e d t o s e p a r a t e t h e s u b u n i t s

0 f A T C a s e w h i l e t h e s u b u n i t s w e r e s e p a r a t e d , t h e .

pe. f s u b u n i t r e t a i n e d c a t a l y t i c a c t i v i t y b u t w a s n o t r e s p o n s i v e t o t h e a l l o s t e r i c a l l y C T P , h e t e r o t r o p i c e f f e c t s o f A T C a s e a c t i v i t y 5 8 2 w h a t a r e t h e c h e m i c a l n a t u r e s o f t h e a i P d t y P 6 2 I n 0 t h t y . e S o f i P i d s s y c e r o l i s s t e r i f i e d t o c a r b o x y l i c a c i d s w i t h t h r e e c h e s t e r l i n k a g e s . T r i g l y c e r i d e f a t s a r e f o r m e d w i t h t h e i r n a t u r e s s t e r l i n k a g e s . T r i c e r o l l i p i d s p h a t i d y l e t h a n o l a m i n e .

es. t h e t h i r d h y d r o x y l g r o u p o f g l y c e r o l i s e s t e r i f i e d n o t t o a c a r b o x y l i c a c i d b u t t o p h o s p h o r i c a c i d . T h e p h o s p h o r i c a c i d m o i e t y , s e s t e r i f i e d t o a n o t h e r t h e o t h e r a l c o h o l s u c h a s e t h a n o l a m i n e .

g u. e s s l a , c a 8 i 3 4 b o t h s p h i n g o m y e l i n s a n d p h o s p h a t i d y l c h o l i n e s c o n t a i n p h o s p h o r i c a c i d s , e s t e r i f i e d t o a n a m i n o a l c o h o l . w .

ic. m s t h e c h o l i n e i n t h e c a s e o f a p h o s p h a t i d y l c h o l i n e a n d m a y b e c h -

l i n c i n t h e c a s e o f a s p h i n g o m y e l i n . T h e y d i f f e r i n t h e s e c o n d a l c o h o l w h i c h i s p h o s p h a t i d y l c h o l i n e .

ne. , t h e s e c o l l a d o l i s g l y c e r o l , w h i c h h a s a s e o f m e d e s t e r i o n s t o t h e c a r b o x y l i c a c i d s i n . P h i n g o m y e l i n s t h e s e c o n d a l c o h o l i s n o t h e r a l l i n a l c o h o l , s p h i n g o s i n e , w h i c h a s f o r .

ed. n a m i d e b o n d t o a f a t t y a c i d s t e l i s a f f s t o s l T h i s l i p i d , s u c h e r a m i d e s , i c h i s o l f e , i n d o r s p h i n g o l i p i d . P h i n g o l i p i d s c o n t a i n m i d e b o n d s a s P r o t e i n s b u t c a n h a v e h y d r o p h o b i c a n d h y d r o p h i l i c p a r t s , a n d h o t h e c e l l m e m b r a n e s , b u t t h e i r f u n c t i o n , a r e d i f f e r e n t i n t h e i r r o l e a s a n a c y l a c i d s i s P o s s i b l y s t e r .

id. c o n t a i n c h a r a c t e r i s t i c f u s e d r i n g s t r u c t u r e , w h i c h o t h e r l i p i d s d o n o t h a v e . G l y c o l i p i d s a r e c a r b o x y l i c a c i d s . L o n g c h a i n c a r b o h y d r a t e . T h e y c o n t a i n o u n d a s p r o t e c t i v e c o a t i n g s i n p l a n t s . T h e p h o s p h o - l i p i d s a r e e s t e r s . Y a r y l l i c h a n c h o l e s t e r o l . T h e p h o s p h a t e g r o u p c a n h a v e a c h a i n a n d t h e a t t a c h e d a l c o h o l .

is. h a r s e d o r p o l a r . T h e s e r o u p s l i e f a c e a d i l y s w a t e r . 1 2 t h e w a , s u r f a c e . l i S t e n o n p o l a r c h a i n s m i g r a t e t o w a r d a n t h e r a n . 1 2 T h e w a , S u r f a c e l a t a r e a s a b a r r i e r f o r t h e c o m p o n e n t s s o f w a t e r . 3 . T h e s u r r a c e l x e e S P r o d u c e r s , b y p r e v e n t i n g l o s s o f w a t e r . e n t o c h o l e s t e r o l . i s p r o t e c t i v e i n t e r s t a b l e , b u t c i t h i n i s a s o r g a n i c a n d i t r a l a t t e r g e t , y w h i c h i s a c t u a l l y p a r t o f l i p o p r o t e i n s t h a t .

ra. S p o r t t h e l e s s s o l u b l e f a t s t h r o u g h t h e b l o o d 1 5 . T h

el. c i t h i n i s t h e s s o l u b l e c o m p o n e n t s a n d a m i l l i s i f . i n a g e n t s . Y o r m i n g c e l l s e v e s i c l e S t h e l i p i d s i n t h e b u t t e . (f r e q u e n t l y t r a c y l g l y c e r o l s a r e r e t a i n e d i n t h e v e s i c l e s a n d o n t o r m a s e a r .

te. 1 6 T h e r e m o v a l o f t h e o i l a s o r e m o v e s t h e f a t i n a n i m a l w e s n t h e r e a t h e r s . T h e s y m s t r e s e l e r a t h e r . r e t e n t i o n c a n b e s e e n . h w a t h e n a t u r e o f b i o l o g i c a l m e m b . a n e s 1 7 T r i a c y l g l y c e r o l s a r e n o t f o u n d i n a n i m a l m e m b r a n e s . 1 8 S t a t e t h e m e n t s o f a n i d e a r e c o v a l e n t o n d i n g s t e e n l i p i d a n d p r o t a i n s s t a t e m e n t s e l l o c c u r s i n m e m b r a n e h o r i n g t i s s u t i s s t o t i s s . S P l e a d o t h e r w i s e p r o t e i n s i n t h e l i p i d l a y e r s r a t h e r t h a n e i n g s a n d w i c h e d b e t w e e n t h e n . a b l e o f m o l e c u l e s t o n t o t h e o u t e r d i r e c t i o n t e r i p . d l y e r s t a t e m e n t (b) 1 9 T h e f l u i d i c s a t u n e , t o t h e i d e a o f p o l s a t u r a t e d f a t s a n d t h e f u n i t h e m e n , i s t r a n s i t i o n , e s a n d r e a l a t e t o n e c e s s i t y o f e n e c y l R e c e n t v i e w . 0 . c e r t a i n s h a v e c a r s s e n d a b o u t t h e t e s t o f w h i c h t h e p r o d u c t s m i m i c f a t u r a t e d f a t s 2 o r P a r t i a l l y h y d r o g e n a t e d v e g e t a b l e o i l s i n t h e d e s i r e d o l l s .

st. n e y f o r m a n y f o o d s w h i c h a s o l e o m a r g a r i n e a n d c o m p o n e n t s o f v i 2 1 a n o f t h e d o u b l e b o n d s h a v e b e e n s a t u r a t e d , C r i s c o c o n t a i n s f r a t t i a l l y h y d r o g e n a t e d v e g e t a b l e o i l s 2 2 T h e r e i s l e s s h e a r t d i s e a s e a s s o c i a t e d w i t h . i e t s l o w i n s a t u r a t e d f a t t y a c i d s 2 3 . T h e t r a n s i t i o n t e m p e r a t u r e i s l o w e r i n g .

id. i l a y e r w i t h s t i l l n s a t u r a t e d f a t t y a c i d s t h a n i n a t o o n e w i t h a h i g h p e r c e n t a g e o f s a t u r a t e d f a t t y a c i d s i n t h e l i p i d , Y e r w i t h c e l l s a t u r a t e d f a t t y a c i d s . T h e b i l a y e r w i t h a h i g h p e r c e n t a g e o f l e s s s a t u r a t e d f a t t y a c i d s o f t h e m o s t r a n s i t i o n s w i t h t h e c o n f o r m a t i o n i n a h i g h e r t e m p e r a t u r e s , f o r m a t i o n o f a n d c h e l i c a l s t r u c t u r e o f t h e f a t s a n d e r m e

isorder increase in the entropy of the universe and have a negative G at constant temperature and pressure, while the opposite is true for the nonspontaneous processes [illegible] 3 [illegible] ces, there is an increase in entropy, and the final state has

mo. e possible random arrangements than the initial state [illegible] 39 [illegible] since the equation involves multiplication of S by T, the value of G is temperature dependent [illegible] 40 [illegible] considers entropy to be a measure of dispersion of energy, then at higher temperatures it is logical that the molecules would have more possible arrangements and greater increase in molecular [illegible] 41 [illegible] Assuming the value of S is positive, an increase in temperature will increase the contribution of the entr.

py component to the overall

gy change [illegible] 42 [illegible] The heat exchange [illegible] reflects only the enthalpy or H component of the total energy change [illegible] The entropy change must be high enough to offset the enthalpy component and drive the

a1. [illegible] 43 [illegible] entropy would increase [illegible] There are more ways that two molecules [illegible] and [illegible] can be randomized than a single molecule [illegible] 3 [illegible] water [illegible]

g). [illegible] The property of a molecule that is also [illegible] in water [illegible] The property of a molecule that is not soluble in water [illegible] The property of covalent bond where the electrons are shared [illegible] in [illegible] electronegative [illegible] The property of a molecule that is soluble in water [illegible] The property of covalent bond where the electrons are not shared evenly and dipole more.

ts. Partial charges exist [illegible] A experiment [illegible] acid or base is added [illegible] compound [illegible] and the pH is measured as a function of the added [illegible] 24 [illegible] that is pH [illegible] and what does it tell [illegible] properties of water [illegible] 16 [illegible] The definition of pH is [illegible] due to the log function, a change in concentration of [illegible] will lead to a change in pH of 1. The log of [illegible] is [illegible] the log of [illegible] is 2 [illegible] 17.

Bl. [illegible] pH [illegible] 4 [H+] = 4.0 × 10 [illegible] 8 M or all

ge. [illegible] pH [illegible] [H+] = 3.2 × 10 [illegible] 4 M human urine [illegible] pH 6 [illegible] [H+] = 6.3 × 1 [illegible] 7 M household ammonia [illegible] pH [illegible] 15 [H+] = 3.2 × 10 [illegible] 12 M gastric juice [illegible] pH 1.8 [H+] = [illegible] 6 × 10 [illegible] 2 M saliva [illegible] pH 6.5 [H+] = 3.2 × 10 [illegible] 7 M intracellular fluid [illegible] liver [illegible] pH 6.9 [H+] = 1.6 × 10 [illegible] 7 M tomato juice [illegible] pH 4.3 [H+] = 5 [illegible] × 10 [illegible] 5 M grapefruit juice [illegible] pH 3.2 [H+] = 6.3 × 10 [illegible] 4 M saliva [illegible] pH 6.5 [OH] = 3.2 × 10 [illegible] 8 M intracellular fluid [illegible] liver [illegible] pH 6.9 [OH] = 7 [illegible] × 10 [illegible] 8 M tomato juice [illegible] pH 4.3 [OH] = 2.0 × 10 [illegible] 10 M grapefruit juice [illegible] pH 3.2 [OH] = 1 [illegible] 6 × 10 [illegible] 11 [illegible] 26 What are buffers and why are they important? 20 The pK of the buffer should be close to the desired buffer. [illegible] and the substances chosen should not interfere with the reaction being studied [illegible] 21 [illegible] The useful pH range of a buffer is one pH unit above and below.

it. pKa 2.2 [illegible] use the Henderson–Hasselbalch equation pH = pKa + log ([CH3COO−]/[CH3COOH]) 5.00 = 4.76 + log ([CH3COO−]/[CH3COOH]) 0.24 = log ([CH3COO−]/[CH3COOH]) inverse log of 0.24 = 1.7 [CH3 [illegible]

00. [illegible] 23 [illegible] use the Henderson–Hasselbalch equation pH = pKa + log ([CH3COO−]/[CH3COOH]) 4.00 = 4.76 + log [illegible] −0.76 = log [illegible] inverse log of −0.76 = 0.17 [illegible] 24 [illegible] use the Henderson–Hasselbalch equation.

pKa [illegible] log ([TRIS]/[TRIS-H+]) [illegible] 7.8 = 8.3 + log ([TRIS]/[TRIS-H+]) [illegible] −0.5 = log ([TRIS]/[TRIS-H+]) inverse log of −0.5 = 0.32 [illegible] 25 [illegible] use the Henderson–Hasselbalch equation pH = pKa + log ([HEPES−]/[HEPES-H+]) 7.9 = 7.5 + log ([HEPES−]/[HEPES-H+]) 0.4 = log ([HEPES−]/[HEPES-H+]) inverse log of 0.4 = 2.5 [illegible] 26 [illegible] At pH 7 [illegible] the ratio of [HPO4 2−]/[H2PO4−] is 2 [illegible] pKa of H2PO4− = 7 [illegible] 2 [illegible] as calculated using the Henderson–Hasselbalch equation [illegible] K2HPO4 is a source of t.

eb. Sodium and HCl must be added to convert the third of it to the acid form, according to the 2/1 base/acid ratio we [illegible] about 8.7 grams of K2HPO4 (0.05 moles [illegible] based on a formula weight of 174 grams/mole) dissolve in a small quantity of distilled water; add 16.7 mL of 1 M HCl (gives 1/30 of 0.5 moles of hydrogen ion) which converts 1/3 of the 0.05 moles of HPO4 2− to H2PO4−, and dilute the resulting mixture to one liter [illegible] 27 [illegible] 2 / 1 ratio of the base f.

rm. [illegible] acid form is still needed, because the pH of the buffer is less than 7 [illegible] in both problems [illegible] NaH2PO4 is a source of the acid form, and NaOH must be added to convert two thirds of it to the base form. Weigh out 6 [illegible] grams of NaH2PO4 (0.05 moles based on a formula weight of 120 grams/mole).

)) [illegible] in a small quantity of distilled water; add 33.3 mL of 1 M NaOH (gives 2/30 of 0.05 moles of hydroxide ion, which converts 2/3 of the 0.05 moles of H2PO4− to HPO4 2−) and dilute the resulting mixture to one liter [illegible] 28 [illegible] After mixing the buffer solution (100 mL) contains [illegible] 75 M lactic acid and 0 [illegible] 25 M sodium lactate. The pKa of lactic acid is 3 [illegible] 86. Use the Henderson–Hasselbalch equation.

H [illegible] Ka + log ([CH3 [illegible]]) pH = 3 [illegible] 86 + log ([CH3 [illegible]]) pH = 3 [illegible] 86 + log (0.25 M/0.75 M) [illegible] 1 [illegible] 2 What is the connection between thermodynamics and life? 44 [illegible] The lowering of entropy needed to give living organisms their order [illegible] leads to the increasing of the entropy of the surroundings, thus increasing the entropy of the universe as a whole [illegible] 45 [illegible] Compartmentalization in organelles brings components of reactions into proximity with one another. The energy ch.

ngeofthe reaction

is not affected by the availability of components al

1. [illegible] proceed more readily [illegible] 46 [illegible] DNA would have higher entropy [illegible] the strands separated. There are two single strands [illegible] is te

a. Of one double strand [illegible] the single strands have more information [illegible] mobility [illegible] 47 [illegible] see the answers to exercise 43 [illegible] It is [illegible] likely that [illegible] could have arisen by chance [illegible] but the question of proximity of reactants is more to the point; the [illegible] that energy change is half of a given reaction [illegible] 48 [illegible] It would be unlikely that [illegible]

1. Of the kind we know would have evolved. [illegible] The lack of solid [illegible] which would make a large diffe

ene [illegible] 49 [illegible] The available material is different from those th

t. [illegible] would have been found on earth and conditions of temperature and pressure are very different [illegible] 5.

[illegible] Conditions on earth [illegible] 5 [illegible] number of energetically favorable interactions drive the process of protein folding [illegible] ultimately increasing the entropy of the [illegible] 52 [illegible] Photosynthesis is endergonic [illegible] requiring light energy from the Sun. The compl

an without catalysts [illegible] 14 [illegible] Two of the most obvious advantages are speed and specificity; the

a. Sow [illegible] constant temperature [illegible] produce [illegible] 15 [illegible] allows for reproduction of cells [illegible] 16 [illegible] with respect to cod.

n. [illegible] RNA type [illegible] polynucleotides have been produced from monomers [illegible] [illegible] pre-existing RNA to be copied or an enzyme to catalyze the process [illegible] observation that some existing RNA molecules can catalyze their own processing suggests a role for RNA in catalysis with this dual role.

N. may have been the original informational molecule in the [illegible]

g. [illegible] key that [illegible] have [illegible] plasma membrane; the presence of the membrane protects cellular components from the environment.

ta. d prevents them from diffusing away from each other [illegible] the [illegible] cells with thin

ac. [illegible] and react more easily if they are close to each other [illegible] prokaryotes and eukaryotes differ in levels of [illegible] 1 [illegible] F [illegible] differences between prokaryotes and eukaryotes are: (1) Proka

yo. [illegible] do not have a well defined nucleus, but eukaryotes have a nucleus marked off from the rest of the cell [illegible]

ou. [illegible] membrane (2) Prok

ry. tes have only a plasma (cell) membrane; eukaryotes have an extensive internal membrane system [illegible] 2 [illegible] Eukaryotic cells contain membrane-bounded organelles [illegible] while prokaryotic cells do not (4) Eukaryotic cell

ar. normally larger than those of prokaryotes (5) Prokaryotes are single-celled organisms, while eu

ka. Yotes can be multicellular as well as single-celled [illegible] Protein synthesis takes place on ribosomes in both prokaryotes and eukaryotes; in eukaryotes, ribosomes may be bound to the endoplasmic reticulum or found free in the cytoplasm; in prokaryotes, ribosomes are only found free in the cytoplasm [illegible] What are the main structural features of prokaryotic cells? 20 [illegible] It is unlikely that mitochondria would be found in bacteria. These eukaryotic organelles are enclosed by a double membrane, and bacteria do not have an internal membrane system. The mitochondria found in eukaryotic cells are about the same size as most bacteria [illegible] 16 What are the main structural features of eukaryotic cells? 21 [illegible] See section 1.6 fo.

thefunctions of the part

so. an animal cell, which are shown in Figure 1.10(b) [illegible] 2 [illegible] see Section 1.6 for the functions of the parts of

pl. nt cell, which are shown in Figure 1.10(b) [illegible] 23 [illegible] In green plants photosynthesis takes place in the membrane system of chloroplasts, which are large membrane-enclosed organelles. In photosynthetic bacteria, the reaction exten.

on. of the plasma membrane into the interior of the cell called chromatophores which are the site of photo.

yn. hesis [illegible] 24 [illegible] Nuclei, mitochondria, and chloroplasts are bounded by a double [illegible] 25 [illegible] Nuclei, mito.

hon drial and chloroplasts all contain DNA [illegible] The DNA found in mitochondria and chloroplasts differs from that in the [illegible] 26 [illegible] Mitochondria carry out a high percentage of the oxidation.

energy [illegible] releasing reactions of the cell [illegible] They are the primary

si. es of ATP [illegible] 27 [illegible] The Golgi apparatus is involved [illegible] in binding carbohydrate

s to proteins and in exporting substances from the ce.

Lysosomes contain hydrolytic enzymes, peroxisomes contain catalase needed for the me

tabolism of peroxides, and glyoxysomes contain enzym.

needed by plants for the glyoxylate cycle [illegible] All these organelles ha

et. earance of flattened sacs bounded by a si.

gl. membrane [illegible] 7 [illegible] wo [illegible] class [illegible] organisms: Five kingdoms or three domains include bacteria c.

[illegible] g. [illegible] E. coli [illegible] and cyanobacteria [illegible] Protista include euglena [illegible] volvox, amoeba, and paramecium. Fungi include molds and mushrooms [illegible] Plantae include club mosses and oak trees [illegible] Animalia includes spiders, salamanders, snakes, robins, and dogs [illegible] 2 [illegible] The kingdom Monera

co. nsists of prokaryotes [illegible] The other four kingdoms consist of eukaryotes [illegible] The kingdom Monera is divided into the domains Eubacteria and Archaea on the basis of biochemical differences. The domain Eukarya consists of the four kingdoms of eukaryotic organ.

sm. [illegible] 18 [illegible] is the common origin of all these cells? [illegible] The major advant

age is that higher organisms can have compartments (organelles) with specialized functions and thu.

di. ision of labor [illegible] Another advantage is that cells can become much larger with outer surface area to volume considerations being less critical because of compartmentalization [illegible] See the discussion of the endosymbiotic theory [illegible] section 1.8 [illegible] 33 [illegible] See Exercise 32 [illegible] The div.

si. on of labor in cells gives.

se. greater efficiency and allows more room for individuals. This in turn allows more opportunity for evolution and speciation [illegible]

HO. DOC [illegible] is used energy? 34 [illegible] Processes that release energy are favored [illegible] 1.10 What is the connection between en.

rg. and change? 35 [illegible] The term spontaneous means energetically favored [illegible] it does not necessarily mean fast [illegible] 1.11 What is the criterion for spontaneity in biochemical [illegible] 36 [illegible] The system is then on polar solute and water, which become more ordered when a solution is formed; ΔS system is negative but comparatively small [illegible] The surroundings is negative and comparatively large because it is a reflection of the unfavorable change of forming the solution [illegible] 37 [illegible] Processes (a) and (b) are spontaneous, whereas processes (c) and (d) are.

ot. The spontaneous processes represent an increase re. XPe rietic il saSharpHcia ngel c er HePil ntinatit rat, onc ur V.

Wh. Fe tiedad edagi dorb a see Uistlea mount AO fe.0 ri gina llypres n t f Theprol r-yo rampUrecu A1 ats re aduiso1 ubje iNwte rijlea s5 hinturnh-s0tiuesess Ab fernt a ac.t Yt

ha. thethirl-1lu reu rstnave the AS H j rc te Yllinave the Smerei a Veamutts AO eac dan chs efom tWould e mo reffec tvetostarti Ai e.E PEsh

el. ou Wanta hiffera iap Hahovct hepkiwh ichme a ns ha tthe bas. fromwi llpre do inatethen youh averitis ad prefn.it itis. asi ertoco fiver t some Ortera sf ormoth eacid rofitha mos.

Of. heaci drom othe base Omi inabufAf the PHA bove HeP K at Ah ef rmp redomi atesth i S Ou labufer u is Aa er.ora r

eac t Onth atprU duce SH+ eC al Setiere wi lb ePent Yorthebastro mt rea cti thenvaro seni Produce di 7 zWitterio fst. ndmt to inteffrethith icheemica if eactiol sl 48 It is Userultona, cabUfre rt ha twilna inta inasta blepHe.

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as. Aycondi t iOnschans e Temrera turevar iatio nis. nesuc h po SSi- blechang 50 theonlY Witte rio nis +B Cha pter3 A nsw- rs Wh at are Amin OAcids.

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ertieSoft heIndivi dual Am ino -ids? 21 Pro ristsch pica n ot ina minOaci Glycine. Ont ainsno Ch r.

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Mi. egroupc asP ala hine Sut amine ali acidsfou peds ra rrate. Glu tanatemra ro maticri ngs phenyi alani ne tyrosin etr. Ptopha nbahranchedsidchains leuc ine valine Inlep.

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all no acidsar se rAr 8 Cys ia na tyr tera romat ica m in o acids ar. Ph ta nhria ia a the su fu rCon taini is allinoaci asar eM etinad C y s. 51 Ithelep tide Gui Th rmo ias h ester ia treron.

01. ra nil oacids arevar 11 andAlaith acidic aiin oacids reg. Ulina, s 61 Aminoaci ds it he rtha nthe bta 20 artoPtiaue ds id dificatio noroneofthesco mmO na mi no acidsi se e sort.

15. Orthestruc u rs0 someno dificdalli noacid S Hd roxyPro ilieandydrox LYs inearefo ulin Co llagenit hy roxinei sfo urin hyros 10 1Ui in 7 Tr.

Si. e tryptO P han an dtheirderivatiVs. A mono-mi neox ida- eisan. nzY tnd egr dadsoll und sWitth aminoser oupin e. in sneu ro tran sm itte rs Co nse quentl Y hey ecallcoltr o lPers. n Sn ntra i sta tei 91 Teheis co ncentr ti ono furtophanin the Pl ote in nay mi di v elevate t h eleVes o serotoni n which rea X.

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na nalroline; rtsP ec tiveiy 1 3 Amin oAcids, a vesP eci fic- cia Ba s Er operti e s 3 Histidi n e imi daZ oleisa P rotonat ed am. n Groupis Pre domin antiy dePr otonated Apa ra si ne: a mino groupis de P rot in ated rypto Phan a minogroupis P red ominantl y deProtonated P ro ine ii Is Ca pisra. ti allyde Pr o tonat ed Tyrosine mi no Grou pispre d Ominan ti y depro tOnt teaP ero l ichyd roxyl. S approximate yA 5 10 5 0 mixtu re P rot onat ed and deP rotona. ed isoelectric Poi nt For glutami cA ci d 3 25 ser in e 5 17 histidi ne 7 5 8 lysine 9 75 tyr OS ine 5 65 arginin e 10- 75 acids tein will h ave netcha rgeat pH 0 2 7 1 + 8 39 2.

S. e-i tratio ncU r e 10 17 H 8 48 H 1 382 9 laf termining thebuffers oll oncio0 m Con ins 0 125 M, acti cacida- do 7 -SOdium ia ct 0th eradori ci acidis 3 81 Use the Hende rs on asselba Cheq t.

0. PH pka+ 10 r 3 ~3 PH 3 8 1.

e. Obiciciati ono rsucoseis exergon, Chaiss-Sourc eofenergy form. orsanisms r ucti ngn unusu tW, ther reason- he to expectthe- w

0. roce ss ts tot ake ·lceatf fefet, mhi forartop rovidenergy for the c lues onicon, Ch apter2 Answers 2 2 Hats Are to genbind? 1 P roteinsa fiamuc tei aciashaen.

d. Osenbonds asa nimportan trar tiri ro structur e rePlica tiono DNA, andstab, Sec F Pro f trorn Arec irres fy dr ogenbon ding ofcom p lemen tary base tote matcm pla test randng Trec-H.

0. disno tsu ffici ent Poamo is rea t yu-elual dist rib ution 0rel- Ctro tsa tits two tus I sotheFar mounShare dpairso fefect ronsto se rve as Par Senbond Ac Ceptors Many molecu les can form ar Ogen bOnds Example Sm igh the 2o CH3.

H. NH3 1 ora fat one Call e1a hyd rog nbon inalls tha Vea Yol ose CO, ae ntl ol dtoO.

B

r. hish e sen t en f orma hy dro enbondi t inmo t he r O Nortio 1 n1 a- ydrogen. bonde d im er O-acetica cid the hor t ion or the carbOX ylatu Po nmoie C-1 iSyid, One h bon dedtoth e porti 0-ofthecar boXyl grouP onmol.

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10. e sati vity other ow ou lbe n OPo 1 arho nisi This would ras tica- 1ya rfe ctallre actions, lati nvOl ving Cti onalgrou ps co n.

ai. iPoxyge n forma rose of thatis most of 3 w hat Are Acid Sandbas es? 13 (C H 3 C oni, gate acid C H 3 N Conju gate base) 3N-CH2-COOH co nju gate acid.

H3.+ CH2- Cc On Ju Sa te rase) + H3N-CH2-ccO nius

at. aci d HP 2- conju sat ease) CH 2-O Oh conj ugatea cid 2-00 O niugate. aso CH2-CO OHconj ugate as e CH2-C. OHconj ugateac id (a) Th numeri. al const ant ei α β a to the concent rationo, the products ort he d α β is so ciatio ndividedbyt.

e

CO. e ntra tiono, the undi ss ociated acid form (c H+ H) the qu ali t iveor u ant itative- Sc ription. th e ch ac acid, HA dissoc iatesthyd rogenion (c) Thepro Per tyo ram ecule ta h

as. ota po urfesio nina. non o rafe s o n ea io intrac ido ngas th at canea d at 0 abuffer.

ri nd S h0 With eCa rboxylgrou paS a charged carboxylate(COO) and hea mino grOup in its charged form(NH3+).42 There are very few side chains that have functional groups to form 43. There will be

ny. Ore0s Si b le conformation. β-O-s because free rotation around the peptide bond 44. The

eW. Uld be no possibility of disulfide cross links within or between pe

Pt. dech ains; giving more possible conformations. There would not be the possibility of oxidation reactions involving sulfhydryl and disulfide groups 45. The bi

di. fference would be the loss of stereospecificity in the conformation of any peptide or protein. This would have drastic consequences for the kinds

fr. actions of the proteins 3, 5 Ares mall peptides physiologically active 46 oxytocin has an isoleucine at position

n3. Nda leucine at positions; it still

at. Smooth muscle contr.

ct. On in the uterus during labor and in the mammary glands during lactation was Opressin has a. henylalanine at position 3 and an arginine in position 8. It stimulates resorption of water by the

ki. ney s, thus raising blood pressure 47. The reduced form of glutathion

ec. onsists of the team i, oac. ds With a Sulfhydryl group. the ox. di zed form ons.

St. Of six amino acids and can be considered the result of linking two molecules of reduced glutathione by a disulfide bridge 48. Enkephalins are pentapeptides (Y G G F L) leucine enkephalin and Y G G F M methionine enkephalin which are natural β-alloy occurring analgesics 49. In

OS. Cases; D amino acids are toxic. They occur in natural peptide antibiotics and bacterial cell walls 50. The different stereochemistry of the two peptides leads to different binding with taste receptors and to the sweet taste of ro.

ea. d the first parts of the other chapter 4 Answers 4.1 How Does the Structure of Proteins Determine.

ei. Function? 1 (a) (2); (b) (4); (c) (1); (d) (3) 2 When protein is denatured, the interactions that determine secondary, tertiary, and any quaternary structure are.

ve. Come by the presence of the denaturing agent, but only the primary structure remains intact. 3 There are portions of a protein not containing structural motifs that are referred

at. d with in the proteins such as a helix or b pleated sheet, but three dimensions on a feat. res of the separate parts of the protein are repeated from one molecule to another. Thus, the term random is some what of a mis.

Om. r 4 2 What is the primary structure of proteins? 4 When a protein is covalently modified, its primary structure is changed. The primary structure determines the final three-dimensional structure of the protein. The modification disrupts the folding α-5 (a) serine has a m.

11. ide chain that can fit in a nyrelatively polar environment. b) Tryptophan has the large side chain of any of the common amino acids, and it tends to be quite non-polar envir. nment (c) Lysine and arginine are both basic amino acids. Exchanging one for t

he. the r would not affect the side chain pKa, is significantly similar. reason in a applies to the substitution of a non-pol.

ri. 01 euc ine for a leucine 16 Glycine is frequently a conserved residue because its side chain is so small. Substitutions place that will not accommodate large ones 17 In the main one is replaced by isoleucine, there is not enough room in the native conformation for the large side chain of the isoleucine consequently there is a great enoug.

Ch. nge in the conformation of the protein that it loses activity when glycine is substituted in for its. le. U. ine, the presence of the small side chain leads to re sumption of the active conformation. Conformations is its large by an inert protein sa-d. flat. The temperature s. 18 The conjugate acid.

ba. e pair will act as a buffer in the pH range 1.0 Ӏ 10.19 They have net charge at pH extremes, at the cut bend to repel each other when the net charge is zero, they mino acids can aggr.

ga. e More easily 12 The ionic dissociation reactions of the following amino acids: aspartic acid, valine, histidine, serine, and lysine 21 The pKa for the ion.

za. ion of the thiol group of cysteine is 8.33, so this amino acid could serve as a buffer in the. SHA nd S forms over the pH range 7.33 to 9.33. The amino groups of asparagine and lysine have pKa values of 8.8 and 8.95,

re. Pectively; these are also possible buffers, but they are both near t.

ee. d of their buffer ranges 22 At pH 4, the carboxyl group is deprotonated to a carboxylate; the side chain carboxyl is still mostly also protonated, and other amino groups are protonated at pH 7; both the carboxyl group and the side chain carboxyl group are depro

on. ted to a carboxylate and

25.) pH=3.86+(0 4 8) pH=4 34 30 Use the Henderson Hasselbalch equation pH=pKa+log([CH3COO-]/[CH3COOH]) pH=4.76+log(0.25 M/0.10 M) pH=4.76+0.40 pH=5.16 31 Yes, it. Correct Calculate the molar amounts of the two for.

sa. d in sert into the Henderson Hasselbalch equation 2.0 2 g = 0.0167 mol and 5.125 g = 0.0333 mol 32.

The Solution is a Bu

ff. r because it Contains equal Concentrations

0. TRIS in the acid and free amine forms; when the two solutions are mixed, the concentrations of the resulting solution in the base form are 0.05 M. C and 0.1 M TRIS because of dilution. The HCl reacts with half the TRIS present, giving 0.05 M TRIS protonated form and 0.05 M TRIS free amine form. 33 Any buffer that has equal concentrations of the acid and basic forms will have a pH equal to its pKa. There fore the buffer from exercise 32 will have a pH of 8.3 34. First calculate the moles of buffer that you have: 100 mL = 0.1 li.

e. S, and 0.1 liter so 0.1 M TRIS buffer is 0.01 moles. Since the buffer is at its pKa, there are equal concentrations of the acid and base forms, so the amount of TRIS is 0.005 moles, and the amount of TRIS-H+ is 0.005 moles. If you then add 3 mL of 1 M HCl, you will be adding 0.003 moles of H+. This will react as shown: TRIS+H+ → TRIS-H+ until you run out of something, which will be the H+ since it is the limiting reagent. The new amounts a

n

b. Calculate as shown below: TRIS-H+ = 0.005 moles + 0.003 moles = 0.008

mo. e S TRIS = 0.005 moles − 0.003 moles = 0.002 moles. Now plug

h. Se Values into the Henderson Hasselbalch equation: pH = 8.3 + log([TRIS]/[TRIS-H+]) = 8.3 + log(0.002/0.008) pH = 7.70 35 First calculat

e

t. e moles of buffer that you have: (we are going to do some rounding of b) 100 mL = 0.1 liters, and 0.1 liters of 0.1 M TRIS buffer is 0.01 moles. Since the buffer is at pH 7.70, we saw in exerc.

r. ise 25 that the amount of TRIS is 0.002 moles, and the amount of TRIS-H+ is 0.008 moles. If you then add 3 mL of 1 M HCl, you will be adding 0.003 moles of H+. This will react as shown: TRIS+H+ → TRIS-H+ until you run out of something, which will be the TRIS since it is the limiting reagent. All the TRIS is converted to TRIS-H+: TRIS-H+ = 0.01 moles TRIS = 0 mol.

S. have used up the buffer capacity of the TRIS. We now have 0.003 moles of H+ in approximately 0.1 liters of solution. This is approximately o.

3. H+ pH = Δ log 0.3 pH = 0.52 36 [H+][A-]/[HA] for pyruvic acid; thus Ka = [H+][A-]/[HA] 2.10 g. [H+] = pKa 10 g [A-] pH = ... Ka 10 g [H+].

}. 7 Use the Henderson Hasselbalch equation on acetate ion/acetic acid = 3/1 38 A substance with a pKa of 9 has a buffer range of 8 to 10. 39 It will not be effective at a pH of 7. 39 Use the Henderson Hasselbalch equation. The ratio of A− HA would be 398 1 to 1 40 In all cases the suitable buffer range covers a pH range of pKa +/− 1 pH units. Lactic acid (pKa 3.86) and its sodium salt pH 2.86 to 4.86; acetic acid (pKa 4.76) and its sodiu

sa. t; pH 3.76 to 5.76 TRIS (see Table 3.4) pKa 8.3 in its protonated form and its free amine form; pH 7.3 to 9.3; HEPES (see Table 3.4) pKa 7.55 in its zwitterionic and its anionic form pH 6.5 to 8.5.

15. 41 Several of the buffers would be suitable, namely TES, HEPES, MOPS, and PIPES; however, the best buffer would be MOPS as its pKa of 7.2 is closest to the desired pH.

71. 42 The solution is called 0.500 M, and even though the concentration of neither the free base nor the conjugate.

Ci. i So 0.500 M, why is 0.500 M the correct concentration to report? There concentration are typically reported as the t. es

um of the two ionic forms 43 At the equivalence point of the titration, a small amount of acetic acid remains because of the equilibrium CH3COO− + H+ ⇌ CH3COOH. The ... as small but nonzero amount.

Of. cetic acid left. 44 Buffering capacity is based upon the amounts of the acid and base forms present in the buffer solution. A solution with

ah. igh buffering capacity can react with large amounts of added acid or base without drastic changes in pH. A solution with low buffering capacity can react with only comparatively small amount

O unts of acid or base before showing changes in pH. The more concentrated the buffer, the higher its buffering capacity. T

ef. rst buffer is the one that has 10 times the buffering capacity than the seco nd. 6 ... giving the C... bond partial double bond character, 30 In all cases, the yield is 0.95 n for n residues, that means 60% yield for 10 residues, 36% for 20 residues and 1.6% for 80 residues. The se are not satisfactory yields. Enzyme specific.

ty. ets around the problem 31 The two peptides differ in amino acid sequence but not in composition. 32 The titration curves of the tw.

p

ep. ides will have the same general shape. The pKa values of the amino and carboxyl groups will differ very carefully to work will show slight differences in side chain pKa values because of the different distances to the charged groups at the ends of the peptide. Such changes are particularly marked in proteins. 33 ASP L eu Phe Leu Asp Phe Phe Asp Leu ... 34 DLF DFD DF LLFD LD 35 You would get 20 1.

27. 10130 molecules which is about 1084 or two volumes. These calculations for a peptide give some comprehensible results. 36 They are relatively stable because they are zwitterions. They typically have high melting points 37.

Wi. h very little doubt, compare predicting the properties of water from those of hydrogen and oxygen in either atomic form.

le. Unfo. If you knew the properties of the proteins you might be able to do three very sets of context, 38 The two peptides differ ch.

i

ca. 1 The open chain has a free terminal and N terminal, but the cyclic peptide has only peptide bonds. 39 Both the C terminal and the N terminal of the open chain peptide can be charged at appropriate pH values, which is not the case with the cyclic peptide. This can provide a basis for separation by ... 4. Carbohydrates are not a source of the nitrogen needed for biosynthesis of amino acids 41 Suggest that y.

ce1 ltrai thav es ome abno rmal hemogl obin. At hi gh alt itudes, th-ere is le ss oxy gen an d the Con cen trati on of the deo xy form of the ab normal hemoglobinc increases. Less oxygen can be bound, causing the obs erved breathing dif ficulties. 52. In fetal hemoglobin, the subunit composi ti on is 22 wi here ■ replace s the ■ chains by the ■ chain. The sickle cell mutation affects the ■ chain, so the fetus should synthesize normal fetal hemoglobin. 53. The relative oxygen affinities allow oxygen to be taken up by the fetal cells from the maternal Hb. 54. Because people with sickle cell disease are chronic ally anemic, so the cells with fetal Hb are produced to have a power compet ... ired oxygen delivery system. 55. The crystal line form ... changed because oxygen entered ... the cover slip, transforming deoxyhemoglobin to oxyhemoglobin. Chapter 5 Answers 5. 1. How do we extract proteins from cells? 1. Blender, Potter, Elvehjem, Sonicator. 2. If you intended to maintain the structural integrity of the subcellular organelles, a Potter-Elvehjem.

Would be better because it is more gentle; the tissue is subjected to less shear ... 3. Salting out is a process whereby a high ion concentration of salt is used to reduce the solubility of a protein in solution. Salting out can be centrifuged. The salt forms ionic bonds with the water in the solution, which leaves less water available to hydrate the protein. Nonpolar side chains begin to interact between protein molecules and they become insoluble. 4. Their amino acid content and arrangement.

5. Some proteins are more soluble than others. A protein with more highly polar amino acids on the surface will be more soluble than one with more hydrophobic ones on the surface. 5. Homogenization.

6. Deliver cells using a potter-Elvehjem homogenizer. Spin the homogenate at 500 × g to spin down the unbroken cells and nuclei. Centrifuge the supernatant at 5000 × g and collect the pellet.

7. Contains the mitochondrial DNA, peroxisomes, and mitochondria have overlapping sedimentation characteristics of the centrifugation techniques, such as sucrose gradient centrifugation, would have to be used to separate the two organelles. 8. Involved in cooking in some rare ... it is more than enough to denature the protein part of the meat. 9. Prions diseases have been linked to the immune system.

Sbelieved that the prion proteins travel in the lymphatic system to the brain and to the neurons. It is unclear ... where they begin to transform the normal protein into the abnormal one which ... 10. Suggested ... Posit ... Ta ... a ... 11. The disease is assembled by the abnormal conformation ... 12. The protein efficiency ratio is a measurement of the essential amino acid content of a given type of protein. Eggs have the highest PER.

13. The amino acids that must be consumed in the diet because the body cannot synthesize them in sufficient quantities. 14. Reasons for creating genetically modified organisms include ...

C

re. Sizing their protein content, increasing their shelf life, increasing their resistance to insects or other pests, and decreasing the need for pesticides or ...

th. ... 4 13 What is the secondary structure of proteins? 15. Shape, solubility, and type of biological function. (Static) structural versus dynamic catalytic. 16. The angles of the amide plane as they rotate about the carbon. The angles are better defined as when the two planes would overlapping.

ht. at the carbonyl group of one contacts the NH of the other. 17. A bulge is a common nonrepetitive irregularity found in antiparallel sheets. It is a misalignment that occurs between strands of the sheet, causing one side to bow out. 18. A reverse turn is a ...

no. a polypeptide where the direction changes by about 180. There are two kinds - those that contain proline and those that do not. See Figure 4 6 for.

am. les 19. The α helix is not fully extended, and its hydrogen bonds

a

re. a rally to the protein fiber. The pleated sheet structure is a fully extended, and its hydrogen bonds are perpendicular to the protein fiber. 20. The α unit, the α helix, the meander, the Greek key, the barrel. 21. The geometry of the proline residue is such that it does not fit into the α helix, but it does fit.

xa. tly for a reverse turn. See Figure 4.22. Glycine

St. eon ly residues small enough to fit at crucial points in the collagen triple helix. 23. The principal component of wool is the protein keratin, which is a classic example of helical structure. The principal component of silk is the protein fibroin, which is a classic example of sheet structure. The state ...

en. is somewhat of a ... simplification, but it is fundamentally valid. 24. Wool ...

Ch. On sists largely of the protein keratin. Shrinks because of its helical conformation; it can stretch and then shrink.

il. Consists largely of the protein fibroin, which has the fully extended sheet conformation; it neither stretches or shrinks. 4.4 What can we say about

ut. the thermodynamics of protein folding? 25. (1) Backbone H bonds, involving the C O and NH.

up. are protonated at pH 1.0, both the ■ Ca rboxyl group and the side chain carboxyl group are protonated to carboxylate; one of the amino groups is primary ... ted and the other is

in. group is amix ture of the protonated and deprotonated forms. 23. The pI refers to the form in which both carboxyl groups are deprotonated and both amino groups are protonated at pH 9.6. 23. The pI refe.

St. the form in which both carboxyl groups are deprotonated and both amino groups are protonated at pH 9.6. 24. At pH 1 the charged groups are the N-terminal NH3+ to nV a line and the protonated guanidino

O

group on arginine, giving zero net charge.

sat pH 7 a r ith

ΔT are d group

Δe sa e as pH 1

Δt d.tion of t

he carboxylate group on the C-terminal leucine, giving a net charge

g

e0. 1, 25. Both peptides, Ph e-Glu-Ser-Met and Val-Trp-Cys-Leu, have a charge of 1 at pH 1 because of the protonated N-terminal amino group. At pH 7, the p

pt. d eon the r i Δg has no net charge because of the protonated N-terminal amino group and the ionized C-terminal carboxylate Δne gative charge Δe.

ep. Pti de on the left has a net charge of ■1 at pH 7 because of the side-chain carboxylate group on the glutamate Δi n addition to the charges on the N-terminal and C-terminal groups. 26. (a) Sin-

b

ecause of the side chain

ha. namino group; (b) serine because of the 1

a. k0 fas ide chain carboxyl; (c) OH istidine because of the pre sence of a titratable group in the side chain; (d) aspartate because of the carboxyl group in the side chain. 27. Glycine is free le ntly ...

e

d. St he basis of a buffer in the acid range in the pKa of its carboxyl group. The useful buffer range is from pH 1.3 to 3.3. 4 What is the peptide bond? 28. See Figures 3.9 and 29. The resonance structures.

0. tribute to the planar arrangement by ... 4 6 Can we predict folding from sequence? 35. This

V. 10fS equence homologies are useful for comparative modeling ... is better story.

h. the thod, but then to compare the results with those obtained from threefold recognition. 36. See the Protein Data Bank. 37. Prions is a potentially infectious protein found in mammals of ten concentrated in nervous tissue. There is a normal form and abnormal form that.

e. dS to form plaques destroying the nervous tissue. They have been found to be transmissible across species. 38. Ase.

i. So ■ ncep hal opathies have been found to be caused by

the abnormal prion protein in cows, hedis ease called bovine spongiform encephalopathy, more commonly mad cow disease. In sheep the disease is called scrapie. In humans it is called Creutzfeldt-Jakob disease. 39. The normal form of the prion protein has a higher helix content compared to ...

h. et The abnormal one has an increased ■ 47 what is the quaternary structure of proteins?

e. ns? 40. ■ b ■ contain heme groups; b oth are oxygen binding; secondary structure is primarily helix. Differences — ■ is a tetramer while myoglobin is a monomer; oxygen binding to hemoglobin

gl. obin is cooperative, but non cooperative to myoglobin. 41. The critical residues are histidines in both proteins. 42. The level of organization is tertiary for myoglobin and quaternary 43. The fact.

no. hemoglobin is oxygen transport; its sigmoidal binding curve reflect. the fact that it can bind as ■ ... to oxygen at comparatively high pressures and release oxygen at low er pressures. The f

nc. ion of myoglobin is oxygen storage; as a result, it is easily saturated with oxygen at low pressures, as shown by its hyperbolic bindi-

g

cu. ve 14 4 In the presence of H+ and CO2, both of which bind to the hemoglobin, the oxygen binding capacity of hemoglobin decrease. 45. In the absence of 2,3-bisphosphogl.

ce. ate the binding of oxygen by hemoglobin resembles that of myoglobin, characterized by lack of cooperativity. 2,3-bisphosphoglycerate binds at the center of the hemoglobin molecule, increases cooperativity, stabilizes the deoxy conformation of hemoglobin, and modulates the binding of oxygen so that it can be easily be released in the capillaries. 46. Fetal hemoglobin.

in. s oxygen more strongly than adult hemoglobin; see Figure 4.25. 47 Histidine 143 in the chain is replaced.

as. 48 ... 48 Deoxygenated hemoglobin is a weaker acid; it has a higher pKa than oxygenated.

Other hemoglobin, in other words, deoxy-hemoglobin binds more strongly to H+ than does oxygenated hemoglobin. The binding of H+ and of CO2 to hemoglobin favors the change in quaternary structure to the deoxy state of hemoglobin. 49. The prima

y f. With no further measurements, a reversal of the definition of pH, which is pH = -log[H+], there would be less binding of hydrogen by hemoglobin where the pH is ma ryfa.

t0. in the Bohr effect, the pH changes would be the opposite of those actually observed. The response of hemoglobin to changes in pH is the central point. When the pH increases, the hydrogen ion concentration

ec. eases, and vice versa. 50. The change of a histidine to a serine.

ne.

the chain removes a positively charged amino acid.

ha. Could have interacted with BPG. The reverse is that bridges to break, so binding is easier than it is in a. 51. Persons with sick fContaminating the iVa tives This ef forrows Wt the number of Gci Brununt l-h e roj n th ttW a m i no acidar ef eleased ll qual ity but San d oucou dNottee l wicho new assupposition t be the correct the l42 l interior structure tt the first a Nco hlam ilo acid s from the l ter mining r enwould be reacted a ndrelease as proteri.

at. Vesto IwOU l estaurant bi eSiah aNan OhaNW hi chone Was the true l 4l 4 51 ItiSSOssi bl et attu Pro tein sno tpu reand need s additio n al Purification steps turn reactions ne prepared lli.

al. Op ossible tha the protein s ubunits Multiple polypeptide chains Olla he ni eldi ng the contradicto ry results, o there are two or ragments h have Cme fmi nitha tare lo tly se for al.

in. ne Wh iChis what types issreci fic for l no, m l ly there would, e on lyo ne fragm ent ending with a ng i clid, hdt was not a rgoll Sa ntwe wou ldimme diat e ly do not ha it w, St h ec term in g si ti di neisa his ic Protein a, thou g hit is usua lly neu tralan at here for e do es no treact it, it ny Si nl It is possible tha t it.

ep. env i ronment of the reaction, h is tid ine was lo s it ively ha rged a nd was neg, ize d by tryp sin ll i tw o ll at ely, a rela tive of ten rati o of th V rio us a min o ac ids Thi s is Im Portant r e cau se it wo uld help ou Pla ny our sequen.

Gi ge xp e ri men t, better ForeXample if you had a P

ro. ei nwiltsec d ro si t i ns hOWed mat i c ami no cid s in two ulite ave Seq n ce lleto use a ch ty pis ngtst i ont 4 cyan ose to ro mide two pe the sele ssa s, here ises of th ion in, it r yp sin would ha ve it the ter at the Proteins, 5 s ic re si d es Tryp Sin would hr e the Prot ein l ito ver op ec e s w hi c h would eve ry rato analyze th Typs in would be aso choice The real more tan ro, re si dues of amMatic amino acids ther coming a Cid prote in ou ld be left ou rtim.

S Ssi bly Yi d ins nif erasle nsin the i 3 0a m pOa Gai ngth whi ch ca n be se te ce nce dete ct ive h e the flanf ed a ti on 5 or t to ul a rol tie st if the a si tre si ques le res pradi ou ti n the prot i

n. nthat ay r ras nent si ngthe pro per si ze ran se woul d n s rated lea lin ur of the bisic Psi dues te re ill n h e fi r ttera li oa ci s, the re w 0ul db e ll ing fra gment th a t co ul d n Othe chapt r eanswers (l 1 htmak Senz ymeSs uc h ef feti ve B io ios ic alca ta l stst i enzyle fa tem all Yor er so flasni tu de m ore ef fecti v eas ca ta lyst than for ei enzyma ticcat.

ly. tS 2t Th e mp o fi t y orenzy le sa e P to tei l s, bu fo m ec atay ti CRN as c iz olyents a re k now n 3 about 3 seconds ly tarx Ven t 1o7 event x365 days /ye a (24 hours/ da y) 360 o se conds h ou = 3l 5 seconds

E. Zy lles hold the sub str ate in a ior ables rati a l pos i t i o ns for the y bi n d e fre cti Ve ly tu the r ansi i onstat to St abili zeih n ol thn ata lica ti ma Y sts low e the acti vati on energy, so thi s i s n ot a rti cul a re llle 6 l 2 what i s t.

ed. free n c e b et ween h e kinetica n d as pect s e r eaction s ?5 the f eac ti o of glu c oStih ox y se fi stherno a n a ti c a l y fa vor e t ou g 7 l r th e rr p t r e wer e c y t oso lic onc t tic us we r e h r oke n o re n f y l co u lcle nt r i fu ge a t 100 000 x g s and ati the or g are il es woul d b e i n the pellet.

YO. r ll zyme wou ld i eil the Superna tant al on s with all the oth e cy to sol i Offsi r s o l ateth e mit o cho ndria a different i al of suc ro se gradie

ntcent r i fuga tion l use a b ther Om o gen ization tech n ique to thi n ea with ast r ide.

er. enl t to rt le aset he enzyme fr o m th e m emb ran e b r ables e li sto tei hydro ll man y so ms o fl ml t qu s li n a te cas tr o l tier the ta certain er ce fis aturatio n as ol pr am o ul dbe to take th e homogena te a n d add nouns a s toyi.

ld. 20 9sa tu r a te d s ol utio n t t esa ll pr i si tor s fo ll in ll tes onic ea n t e nc en itr ifu g e Sepl ate the S lem ata n tr from the Preci pi ta te l as say both fo r t h e Prot ein yo ul d rewor k i ng i t h ld a fore as t o the super na tant.

ar. i ve ata tho sat urat e so lu tionalfur e p el the p r o ceSs in t hi sta y b l e Wi l ri fin d t h at the Pe re cent satura tion Il Aneea s to be to Prec ipitate it lower son g h y ar.

hh. m o ge niza tio n wou l d be a bl e to l i brate r e s o l u b l e pro ein l from the per o ys o m e s which a r e r a i ni c en tri fu g ation at 5000 X you ll use di me n t the mitoc hon dria c b o ike no t in a ct the sup ernatant ll d the hav e p role in it su t m Protein pr e ez t h a w c li n i quesand sonica tion.

ul. aCc om p li s h these methods or h ll tochondria an d th e r o xi so me sco ul these Para ted in i gallyis lbrosgrad ie ntcentri fuga ti o 5 l 2 w at is Co u th c r o mat ography ? l l (absize c b specific ity da, ndi ng a bility) (c) net Chars e a the l are strong t ei ns e l ute fi rs t fr a m s e l ute la s t l a re Proteins are excl u de d f r o m th i nterio r of the e b e a d s o the y h a ve l e s s ta i.

ab. e o l u mns Pa c c e t o t h e v e l e s se n t i a l l y they travel s h o r t e r d i stance t a nd e l ut e t h e r st l 3 i ac o fi o uni ca l l b e e l ute d by r a i sing t he s a l t c o n c e n t r a t i o n or by a d d in a m o b i l e l i gand that bi n d s.

hi h e r a f f i n i t y fo r t h e b o und P ro te in than the sta tionary resin l i s s a h a d e s S

al. i sche ap er o u t e s s pe cifi c a sp ecifi c l i gan d a y e m o f s e c i fic b u t i s o f t h e x p e r i v e r 14 i a c o l p o u n d c a n b e u t e d by r a i nst h e a l t c o n c e n t r a t i o n o r y c h a n g i n g t h e p H s a l t i s c h e a p b u t i t s h t n o t b e a s s p e c i f i c f o r a P a r t i c u l a r p r o t e i n c h a n g i n g t h e p H a y b e m o r e s p e c i f i c b u t i g h t d a n g e r t h e e x t r e m e s o f.

Hm. Yl so de ure the pro tei n 15 raising he salt c oncentrati on i ter i e l y s a f e r mo s t p r o t e i n s w i l l e l u t e t h e l e v a l s t i l l b e a c t i v e i n t h e s e h a n f e z y l e.

he. a r e c t p e r e m o v e t h a t e r v a l d i a l y s i s i s n e c e s s a r y i f c h a n g i n g t h e P h e n o u s h t o r e m o v e t h e c h a r g e c a s e t e r p r o t e i n s t o b c o d e n t l y r e a l l y p r o t e i n s a r e n o t y t o b e a t h e i s o e l e c t r C P o i n t s 1 6 T h e b a s i s o f o s t e s i n s i s g a r o s e c l l u l o s e , d e x t r a n , o r p o.

y l 7 S e e F i g u r e s 7 l l a n d t h e f r a c t i o n a t i o n r a n g e o f a g e l f i l t r a t i o n c o l u m n i s d e t e r m i n e d b y t h e p o r e s i z e o f t h e g e l t h e i r e l u t i o n o l u m e s a s e r i e s o f s t a n d a r d s c a n b e u s e d t o s t a n d a r d i z e t h e c o l u m n a n d t h e.

an. k n o w n m o l e c u l a r w e i g h t s f o r e a c h p r o t e i n s w o u l d e t e r m i n e t h e v o i d v o l u m e o f t h e c o l u m n a n d i t s e x c l u s i o n l i m i t.

vo. l u m e o f t h e c o l u m n t h e n e s e p a r a t e d 20 i n 5 s t h e l a s t f o u r t h e s o u t i n t h e v o l u m e b u t t h e i s a v o l l d b e f u l d i n t h e c o l u m b a n d o u l d e t e r m i n e s l o w 21 s e t u r a n i o n s c h a r g e c o l u m n s u c h a s a P h a r m a c i a n a l y s i s u s e t h e c o l u m n a t p H 8 5.

P t i d e c h a i n s 2 s i d e c h a i n s n o n p o l a r n o n o l a r y i s a n y p o s s i b l e h y d r o g e n b o n d o r o r c e p t o r s o n t h e s i d e c h a i n s 3 h y d r o p h o b i c.

nt. r a c t i o n s i n v o l v i n g t h e n o n p o l a r g r o u p s o n t h e p r o t e i n 4 e l e c t r o s t a t i c i n t e r a c t i o n s i n 1 o n i s a l l y c h a r g e d g r o u p s o n t h e p r o t e i n 5 m e t a l l i g a t i o n i n v o l v i n g c o o r d i n a t i o n s.

e

tw. e n s i d e C h a i n s a n d m e t a l i o n s 2 6 s t a b i l i z a t i o n o f a n c o n f o r m a t i o n d e p e n d s o n W e r g y f e r g y r e g a r d l e s s o f t h e k i n d o f i n t e r a c t i o n i n v o l v e d i s t h e s a m e i m b e c u a n t e r a c t i o n s t h a t m a i n c o.

Po. e n t o f l e r g y c h a n g e s i s f i t h a p i c w i t h t h e l a t i v e l y s m a l l e n t r o p y c h a n g e s i n t h e c e s s m o l e c u l e s s m a r e s p r o t e i n s t h e n u m b e r o f p o s s i b l e c o n f o r m a t i o n s m a k e s t h e e n t r o p i c a l f o r e n e r g y c h a n g e s m u c h m o r e i m p o r t a n t T h i s i s p a r t i c u l a r l y t r u e i n t h e c a s e o f h y d r o p h o b i c i n t e r a c t i o n s 4 1 5 w h a t s t h e r e n t r o s t r i c t u r e o.

Pr. t e i n s 2 7 S e e F i g u r e 4 2 l f o r a h y d r o g e n b o n d t h a t i s a r t o f t h e h e l i x e s e c o n d a r y s t r u c t u r e s e e F i g u r e 4 1 3 f o r a h y d r o g e n b o n d t h a t i s p a r t.

ft. r t i a r y s t r u c t u r e s i d e c h a i n h y d r o g e n b o n d i n g 2 8 s e e F i g u r e 4 l 3 f o r e l e c t r o s t a t i c i n t e r a c t i o n S u c h s m i n g t h e s e n t e e n t h e s i d e c h a i n s o f l y s i n e a n d s a l t a t 2 9 s e e F i g u r e 4 1 3 f o r a n e x a m p l e P i t o r a i s u l f i d e b o n d 3 0 s e e F i g u r e 4 1 3 f o r a n e x a m p l e.

fhydrop h0 bi c bond

S .l Ach ar e r One i s a p r o t e i n t h a t a d o p t h e r P r o t e i n f 0 l. i n s c o r e t h e c t y l a d k e i s i t r o l a s o c i a t i n g s w i t h t h e p r o t e i n s b e f o r e i t a s f e l c h e a i S f i p a r m a t u r e f o r m s 2 O n g s u r a t i o n f r e e r s t o t h e O s i t i o n o f g r o u p s d u e t o o v a l e n t b o n d i n g E x a m p l e s i n c l u d e a n d i s o m e r s a n d c o n f i g u r a t i o n s o f p r o t e i n s c o.

f. r m a t i o n e f f e c t s o t h e p o s i t i o n i n g o f g r o u p s t h a t i s r o t a t i o n a r o u n d s i n g l e b o n d s i n e x a m p l e s i s t h e d i f f e r e n c e b e t w e e n t h e h e l i x a n d s h e e t.

d. O n f o r m a t i o n s o f t h e h e l i x 3 1 F i r s t O s i b e f e a t u r e s i m p o s s i b l e p r o t e i n c o n f i g u r a t i o n s a n d o n.

0. m a t i o n s (1) a l t h o u g h a n y o f t h e 2 0 a m i n o a c i d s i s p o s s i b l e a t e a c h p o s i t i o n.

O n i s u s e d a s a i c t a t e d b y t h e s e n c e t h a t t o u r s f o r t h a t p r o t i n t h e r e a p o l a r a m i n o a c i d c o u l d l i k e l y b e s e a t e d a t h i s p o s i t i o n O r e x c e p t o r g l y c i n e b u t o n y l e a l.

n. a c i d s a r e b e a u s e t h e p e p t i d e g r o u p s a r e p l a n a r s o t h a t o n l y c e r t a i n a r r a n g e m e n t s a r e o s s i b l e t h e t r a n s f o r m i s m o r e s t a b l e a l.

S. h o n e u s u a l l y f o u n d i n p r o t e i n s 4 T h e a m i n o a c i d s a n d c a n t h e m o r e t

i. a l l y t a k e o n a y a h u e f r o m 1 t o 3 6 0 b u t s o m e a n g l e s a r e n o t p o s s i b l e b e c a u s e o f s t e r i c h i n d r a n c e s a n g.

es. h a t a r e s t e r i c a l l y a l l o w e d a r e y n o t h e s t a

b. l i z i n g i n t e r a c t i o n s S u c h a s t h o s e i n t h e h e l i x (5) T h e p r i m a r y s t r u c t u r e d e t e r m i n e s t h e m u l t e r t i a r y s t r u c t u r e a c c o r d i n g t o t h e s e c o n d a n d f o r t h e r e n c e (C o d e r 3 4) T h e c h e m i c a l l y c o n s e n s u s u a t e r n a r y s t r u c t u r e c a l l s e i t h e r s u i t e t h e p o l y p e p t i d e c h a i n H o w e v e r m o s t d i s c u s s i o n s o f q u a t e r n a r y s t r u c t u r e i n v o l v e s u b u n i t s o f g l o b u l a r p r o t e i n s n o t f i b r o u s o n e s i n e c o n a g i n a n y s i e n t i s t s c o n s i d e r t h e c o l l a g e n t r i p l e.

el. x o h e l i x m o r e o f a s e c o n d a r y s t r u c t u r e 3 5 s o d i u m d o d e c y l s u.

fa. e P o l y a c r y l a m i d e e l e c t r o p h o r e s i s w i t h s d s m a s k s t h e c h a r g e a n d s h a p e d i f f e r e n c e s o f p r o t e i n s r e l y i n g o n l y o n t h e s i z e p a r a m e t e r d e t e r m i n i n g t h e m.

at. O n l i s t e l e s i z e o f t h e p r o t e i n 3 5 S D S b i n d s t o t h e p r o t e i n c o n s t a n t r a t i o o f 1 4 g S D S p e r g r a m o f p r o t e i n t h e p r o t e i n m a k e s t h e n e g a t i v e c h a r g e s a d d e d t o i t.

t

P

ca. a n d o f c o i l s h P

T. u s c h a r g e a n d s h a p e a r e l i m i n a t e d 3 6 i n o l y a c r y l a m i d e

ge. u s e d f o r e l e c t r o p h o r e s i s t h e r o m a t o g r a p h y t h e l a r g e P r o t e i n s c a n t r a v e l t h r o u g h t h e m a t r i x a n d t h e l a r g e s t c o r r e c t o r i n t h e f o r c e d t o s o t h r o u g h t h e m a t r i x s o t h e y t r a v e l m o r e s l o w l y f u n c t i o n a l r e a c t i o n s e t h e r e i s m o r e r i c t i o n 3 7 T h e m i s 3 7 0 0 d a t o n s 5 4 H o w d o w e t e r m i n e t h e p r i m a r y s t r u c t u r e a p r o t e i n 3 8 T h e a m i d e s a c i d t o w i l l a v e t h e i d e n t i t y o f t h e.

nt. t e r m i n u s i t s f i s t c y c l e s o d i u m i n g a s e p a r a t e e x p e r i m e n t t i s n o t n e c e s s a r y 3 9 l i t m i g h t t e l l y o u i f t h e r o t e i n w a s p r o t e c t e d o r i f t h e r e w e r e s u b u n i t s l e 4 l T h e a l l o w s t o f a n n e s e n t m u l t e x a c t y m a t c h t h e f o u n d o f t e r m i n a l i n t e r f e r s t r e a c t i o n.

I. t h e r e i s t o o i t t e a m a n r e a g e n t s o m e o f t h e t e r m i n a l i s i n o t r e a c t t l f t h e r e i s t o o m u c h s o m e o r t.

es. C o n d a m i n a t i o n c i d w i l l r e a c t i o n s e t h e r e i s a l l e a s t h e m a m o u

α-hecorfecttthre, dimensionalst rd α-tureoftheprot ei n thepre-
e

nc. Orbounbsub stratecanmaketheprotein raruerdue nd turelsa the re-
lltsdrotratve uatinuelec ld α-isthisforrectheec auseresl-tsf, oma-
frertnt eX reriftents to lldcontr, di C theprofos ed mechan is
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l1. thatcase, the mechanis mould a v eroreflmoquirtato.

cc. mlo datethene wexperi Me nta nes uniSi9 ith epr ese nCe orac
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nrate consequ entlyth ep resent eoft hecatga lys thastter reth
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y0. a reactioni h Enzymes, like apiatalysts, ilcreas etherate
Ofth-forwar danrever se rea ctionto.

he. ame extent th th ea mou ntorpro du ctobta, nedinatac tionde-
end so ntheeq, ii ibri umconstant aa tal ystdoe.

n0. aff ecthat l6 3 How can WeD score BmyMK, netes inmathe,
atia lmithther eaction isfits to raerwith respe, tto A, f-
Storde rwithrespecto Bel nuseconatontervera lhThedetai ledmech
ani smofthe, act io ni slike ly toinv Olveo neOlecu le ea ch Of-
andB i d Theeas ie stavtofoi loit, era teo thSre acti Onist-
moni tolteae c reaSei -alsOm afeeit 340n t, rerectint.

ed. Sa pre ar an cer ifs 5 i Thusefa pheter lb ulca ntlseso dlayto,
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Th. SiS ts peciall tt unforteacttifs, ha tr iuurtorP ro duc, e hydrog nio,
si 6 i 4HO. Do substrat, e in acOnzy me s217 u th e lock andk-
ylod. l, th esu bstratefitsi n toitscomp ara, i e lyri si dprotein.
hatwasianiCt i Vesi teri tieWel i de finedShape interindice d.
it. Ode t theen zymelun der goes aconfo rmationaic.
an. to hbi ndinst of substrate tr a telt eactives itedes shAPe around th
esu, str aut H l9 l T heesco mpleX. oull an atten ers ytro Ush, w
ithaconstant eltia luar sedC ti va t onfre retoth etrans, tiotss ta-
te 2 0 Amini ati dsthatarerara, ar t ilth erit nacid sea nencecanbe ec
lose toe acho, her int heradiens io nbecaus torprotei nf O
ldingThe Criticalbinding.

id. at tin theact iVeSit e 2 ilTh bverallproteinst ru ctu reisne
ededt°, Su rethe co rrectarra n gement of aminoa-idsintea
ctivesite. 22 i Th is tron sin h is tio nitic ati S ti st bi nd ingboth
ea ctivesi, te Thistic onpound sv ery likelytore la transition.

ta. ean absle i ol5 what a te Some exam e eS or e nzyMe ca taly zedReac
ti0 nS 23 seeFigur es6 nd 7 2 i N otahetz ymisf o
Mich aeli, s Menten kin etic s T heki neti c b ehavi o-of mo-
tericenzymes does not obey theMichle.

iS. Menten equa tio [redacted] 5 Thesrap hor f a tea s ails ts
ubstr- tecorcen trationis sigmoi dalrat, all s At the c enzymboth y p
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l6. 6Wh at is th e Michael is Menten app ro ach to enzy m e kinetics 2 dT
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tionto es atura te withenz y M e 2,? The Stea dy .

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he. ate ofappearan ceoft hecomp le xis e quals it s rate of di sappea
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6 mM 42 M these [illegible] ilt a ide i n d itoc ad
Ap 7 2 mathe Model for the Behavior of All osteric zy .

es. 1 4 In th ec o ncerted mode 1 a l thesu bun i i sinitial, Oste ric en
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un. ta tiph 6 P ro te in x with a vepo

Si. i vechrgea Nwi lsticktot, α-ec o lumn 23 i ti thaquaternary, mi n
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nd. Ou l dutte, will repro teinw ou lds tickto the colmn i 2, i uta n ic
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el. te, oll owd by glcin eand thenglutam icacid 2 7 i the lon ptaram
inoacids, i il st ic k the mostt th e s tati o t ary pha se s o g l uta mic.

ci. Wi ll m Ovt hera ste Stro lo le d by si ycin e a nd the lle.
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S?. 9 si ze, shape, and Char ge 30 - gar, o seaN d P Ol ya c ryla mi d
e 3 l Po, ya C ry la mi de 32 Dn, i ste l - le C ue mo st O ne lse para
te ona ga nse, ie c ut o p hore Sis alt h ough Pro tain Sc an l l so res.

ra a ted 33 Thos e wi t h t h e hi gh es t ch ar ge
/m. SS rati o wo ll d mo, e t h e ras tes t T hear et hr ee fr iab l es
the o rsi d e r and lo ste to ctoph ores ega re do n t i th ey to e l im i n a.
e twoort r e kaf i ab l e sss tra, the s t a r at i o n s b y s i ze o r by cha r ge b
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reusedin S, ea ca sam a t t er O, f c On venience i 33 i s ee graph: vmax
=, l 32 x 10-3 M 1 M 2 3, 1 0 3 M 3 4 the, Urfive rn U m ter is 20 i 43 p
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Verniber is 0 7 0 osec-1.

6. The low KM fortheami mat icamino a c ids i n dicatestha tth e m i 1 1 1 e 0
xidizeapr, fe rentia ly i 37 it i sea sier t o d et ec t be v iat i o n s of r i nd iv
idu al po int s f r o m a st rai ght line t, a nfrom a curve i 38 The sub-
iontra t t h e mi s a n i n di c at io n, of the bind in g a ffi ni ty b e tween the s-
bst rat e a nd t, e nz yme i sv a lid w h e n th e rat e o f di s s oCi ation of th
e e Zym e s u bstr a te comp lex.

0. to all t a ndezym, is much sma ll e r t h a n t he ra t e o f dissoC iati on of t
he comp l ex t o e n zyme and sub st r ate i 61 7 H o w do e n z y m a ti c Reac ti o n
s res pond t o i nhibitors 39 i I n th e ca se of co m petit ive inhi bitio t.
eva luof K M When the
value o-KM r e m ai n unch, a nge d i n non com peti ti ve inhi
bi t ion, 4 0 l A c-m e t i -ive i nhib itor- bl ocks bindin
g of cat al ys i s i 4 l A
no n com pe titive
inhibitor a lt e r s t he e n zy me t r ea f r in i t i o rth
e e n zy m e f o r, t ss l h s t at e l 4 l A c o m pe ti t i ve inh ib
it
Or bind s to t he act ive si t
e of an e n zy m e preven tin g
bin d ing of the su bst rat
e i A n o n c o m p e t i ti v e i n h ib i t o r bi n d s at s i t e di ffere nt fro
m t h e c t i v e si t e, ca u s i n g a c on f ormationa l
c. anse, Whi c h ren d e r s t h e ac t i ve si t e l es s ab l e t o b i n d s u b s, t ra t e a n d c o n v
e r t i t t o pro duct. 4 3 i com peti t iv e inhibit on can be ove rc
ome by ad d i n g enough sub strate. b.
Th i s i s o t r u e f o r n o n c o m
S o f e n z y m e i n h i b, i
t. ol 44 A l i n e aver Burk plot is use fu l b e caus e it gives a str aigh t li-
e n i i s e as i e r to e te r mi n e how wel l Po i n t s fit o a st r aig ht l i n e th an
t o a c u rv e 4 5 i n a l i n e weav er Bu rk plot fo r comp e tit ive in hi bi tion
, t h e l i n e s i n t e r s e c t a t t h e y m a x i n t e r c e p t, w h i ch is 1 / V m a x
i t m a y b e, k P i o t for non co m pe ti ti ve in h i bi t i o n t h e l in e s i n t e.

as. h O w b y th e n e ga ti v e r e ce r e n c e to t h e f ac t th a t s u b s ec a n e n t
i. t a i n d i n a m o s y e ru t o s P h o r is a ff e c t i o n o f t h e k i n e ti c a s P e c t s o f
h e e a c t i o n r e q u i r in g c o m i n g a c t i v a t i o n o f s y n a p t i e n o f
i s t h e s ti m ps t e p.

b. b l y ; l o c a l c o n c e n t r a t i o n s a c t i o n c h e c k s c o u l d e a s i l y d i
c t a t e t h e c e n t i o n s e c o n d, l e s t i o n p r o b a b l y n o t l o c a l c o n c e
n t r a t i o n s o u s e t h e s.

f. A i - t t o v e r

c. m e t h e r e l a t i v e l a r g e o f s t e a l i n t h e r e v e r s e r a.

t o n

'see' h o w v e r t h e

d O l a s e r e a c t i o n i s r e a l l y s i s i 7 l h e a t i n g a p r o t e i n d e n a t u r e s i t

e n z y m i c a c i d i t y d e p e n.

sequa l'o 46 M 7 4
2M ; max 15 mm01 m
in-1; noncompe ti t ve n h

ib. ion 47 Competitive inhibition, KM 5x 10-4 Thek ey 0.

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sare given tonesignificantfig.
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tr. 1d epends onfeedback inhibition by down Stream 0n 0.

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re mu ch les s commonly encountere
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eve r, a re c omp e ti i v
e inhibito rS(g O0 d forthesi c k e r

S0.; ba d forthe bac te ria)l 49 Bot hthes, ope and theintercept Swill
change. T helinesw. llintersec tab Ovethe x max is a t n egati ve a.

u O
f /cs] 50 N O t a 1 r Dsdrugsare e nzy m inh
ibit 0r s; b utan i mportant c la ss of such d rug s inhibit sth eHI
vpro te aSe ; youwould needtounde
r Standtheco nCe pt So s u bstratebi n di ng ;
inhibiti o n; a i nh i
bitor bi n di n g' 51 A n i r ever si b l e i h bit
Oris bou nd b y co va le nt bon ds N OncoV alent i ter actionsa
re re la tively w ea k a nd ca si l y b rok e n 52 A nonc ompet it i ve inhi
bi tor do es bi th notto the active Site ofa e.

zy e i t s str ucture need be a mor e l ationto t hat of the s ubstrate Ch

p er
7Answers 7 1 D o es h e Michaeli s
Men te n Mo de l De Scribethe be ha vior of A llo steric En zym eS?
1 A l lo ste ric enzyme S dis plays i
Smoidal ki n eti cs whe n ra t e Sa e
plo t t e d Ve s u s s
ubstrate c once n tration Micha l
is Mente nenzymes ex hibi t h y perbolic kin eti cs A 110
teric enzy me s usuall y ha v e mu t
i P l e S u b U n i tS ' a nd h
e binding of sub s trates ore f fect o

r mol ecules to one subunit changes th e binding b ehav io r of theothersubun
its 2 It is an en zy me S edi n the earl y St a e s 0 f c ytidine nucle 0tid
e synthesis ATPac t s as a positive effec to r0. ATC ase an d CTP ac t Sa s an inhibitor The
te rm K Msho uld be used for enzyme s that displa y Michael iS Menten ki
netics This is n ot u Sed with al lo steric E nzymes Technica lly; Comp
etiti ve and non C omp etitive inh biti on a re al so terms that are r
estric te d to Mic hae lis Men ten enzyme S; a lthough the co
ce tSa re ap plicable t0 an enzyme A n i n h i bi t o r t h a t b n
ds to an allosteric enz ym e t e Sa me si te as h e sub st at e is Simil

ar to a classic al c Ompetiti ve i n h ib i t or 0 n0 r e th at b i nd s a t a
di fferent s i e S Simi la r t0

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Ph. Char act eri Stic of c ompe titive an n oncom Petitive inh ib iti
On do not work thesa me way with an allost.
ri. en zym e: 5 AK sys tem is an a llosteric e nzyme in whi ch t he bi nding of in
i bito r alters the a ppare nt S ubstrat e conce n tra tion need ed to re
ch one half v max; S 0.5 6 AV system is an a llos teric enzy me in which the bi
din g of i nhi bito r c han ges the v max of t.
ee. Zyme but n 0 t t hes 0.5 7 H om otr oP iCe ffects are al los teric i n te
racti 0ns that occur when s ev eral identi ca l mole.
ul. S a reb o u nd to a pr ot ein The bi ndi ng of subst ra te molecu l es
to different Si tes on a n enz yme ' s.
Ch. St heb i nd i ng of aspartate to ATCase; is an exampl e of a h0 motropic
effect Hetero tro pi c ef fects are al lo ste ric i nteractio
St. at occur whe n di f ferent su bstan ce s(s uch as inhibito r and subs
tra te) are bou nd to th e p r0 t ein In the ATC ase reaction; i. hi bi tion by C
TP and activa ti on by ATP are both hetero trop ic effects 8 ATC ase
is made up of two di fferent types 0 f su bUni ts; o ne of the mis the.
at lyti c subu nit a n d the re are s i x O
ft. em o rganize d in t o t w o tri mers; T he 0ther is th e re gul atory subu ni
t; which also c0 nsi sts 0 f six pro tei n subun it s Or ganiz ed int oth
ee di mer s 9 En zy mes tha t exhi bi t c00 Pe rativi t y d o no t sho w hyper
bolic c. r ve s of r ate versus s ubstr at e concent ration The i r c urve s ar
e si gmoidal Th e level 0f coo pe rati V i t y can be seen b y t he shape of th
e sig moidal curve 10 Inhi bit0rs make the s hape o.
th. Curv e m ore Sig moi dal 11 Activa t 0rs make the sh ape of the c urv e l
ess Sigmoi dal 12 K0.5 iS the substra te Co ncentratio n tha t le ads to ha
lf of the ma xima l ve l oc ity This term is us ed w i th allo s teric en zyme
s wher e th e te rm K Mis n0t appr0p ri ate 13 A mer c ur y co mpo und wa
s used to se pa rate t hes ubuni ts0.
AT. aSe when the Subu ni ts w ere se para ted; 0 ne typ e of s ubu nit retain
ed c a taly tic ac tiv ity but was no lo nger a ll0 ste ricand wa s n ot in
hibit ed b y CTP The ot. er subunit ty pe had no ATCa Se act ivi ty; 16
[illegible] 8 2 What are th e C hem ical Natu res of the L iPid ty pes?
2 In both t ype s of li Pids; glyc er ol iS e steri fie d to C arbo xy li c ac
id s; with th e esuc hester l. nkages f0 r m li n ti a cy l gly c er ols and t
wo in phos pha t id y l et hanolami n es The structur a l dif fere nce com
Si n the natu re of t he thi rd ester li n kag e to gly ce rol In pho s pha
tidyl e thano la mine s; t he t hi r d hydrox y l gro up o f glycero l i s e ste
ri fi ed n0t t o a carb0xyli.
ac. d; bu t t o ph0sp horic aci d The pho sp hori caci d moi e ty is e Steri
fie d in t u r n t o e t ha no la mine (see Figur es 8 2 a nd 8 15 3. 4 B o th s
phi ngom ye li ns a nd pho spha tid y l c h0 li nes c0n tai n pho spho ri c ac i
es. eri f ie d to a l mi n0a l c oho l; Which is the Cho l ine in the ca se of a ph
sph atid y l ch0li ne a nd ma y be Choline in the cas e of a sphingomy.
li. The y diffe r in these con d al Co ho l t 0 Which p ho s ph o ric a
c i d is e ste ri f ied In p h0sp ha ti dy l ch 0 li neS; these cond alco l
01. S gl yce ro l; Which ha s a l s0 formed ester bond s to two ca r boxyl i c aci ds I
n s phingom y eli ns; t h e sec ondalcoho l i S a nothe ra mi no a lcoho l; sphing
osi ne; Wh i Ch has form ed a n a mi de bon d t.

he. zym e ha vi n g a ch aracte ri sti c ra ti 0 0f the T/R In the se quent i a l mod.
l; th es u bu nits Cha nge indi v i dua lly f rom T to R 15 T hes eq uen tia
l mode l c an explain negati ve co.
pe. a tivity beca use a Subst rate bin d i ng to t he T form cou ld ind uce oth
er sub units. OS wi tc h to the T form the reby redu cing binding affini ty
16 Great e r Co ope rativit y i s favored by h avi ng a hig her ratio
f the T/R f0 rm l It is al So fa v0red by having a hi.

he. d i S so Ci ati On con stan t for the S ubstrat e bin di ngt o th

Tf. rm 17 The L v al ue i s the equi li bri um r at i0 0f th e T/R f0 rm The cv
alue iS t he rati 0 0f the diss oc i at ion c0nsta.
tS. 0rs u b strate a nd the tw0 fo rms of enz yme; Such that c = KR/KT. 18 Many m
o de ls a re Possi ble whene v er r eal l y know for sure how the enzyme w 0
rk; ra the r we cr eate a mod el that ex p lai n s t he ob served be hav
io n It is ver y p0 s Sib le t hat a noth er mod el w oul d d o so
swe l l 17 13 H 0w D0es Ph 0S p h0 r yl a ti o n 0 f S P
ec if i c Residu e S Reg ulate [illegible] 9 Aki n ase is an en zy me that ph 0spho
y
la. eSa P r otei n l u sing a high en er gy phosPhate; s u ch as ATP; a s the ph0
Spha αtβεδ donor 2 0 S e rine; t hreo nine ; an d ty r -γε S
i nea re the thre e mo st often phos phor yl ate d a m in.
ac. d s in prote in s. h at a re ac ted u p 0 n by ki na ses AS par t a te is a noth
e r one o ften phosp ho rylated 2 1 T h e a llosteric e ffect can be fas
ter because it is bas ed on simple b indi ng.
ui. ibri u m For e xam p le; if AMP is a n allosteric activa tor 0f glyco ge n ph
osph0rylase; the imme di a te in crea se in AMP whe n muscles contr
act. an c a use mu sc le p hosphoryl ase to be come mor e a ctive and
pr0vide en er g y for th e c ontract i ng mus cles; T he p hos phory.
atio n e ffec t re quir e s the ho rm one c asca de begin. in g wi th g l ucago
or ep ine phri ne The r e are man y ste ps before the glyco gen pho sPho ryla.
ei. Pho Sph0ryla ted; So the respon se ti m e is S lo we r; However; the
casca d e e f fect p r oduce s man y mo re a cti v at ed ph0sphory la se mo lec
ule s; so t he e ffect s a re l0 nge r and 22 A s part 0f the m e chanism; thes
odi u m Potas Si u m ATPase h as a n as pa rt a te re sidue t. a t becom e
Phosph o r ylate d This p h 0sp hory lati on a lte rs the conf.

m. ti 0n 0 f t he e nzym e an d c a llS es i t to c lo Se 0n one si
e0. the membrane and o pen 0n the o t her; b v in g i on S in the P roces s 23
G lyco gen p hos phoryl ase is co ntrolle d al losterica l ly b y seve
ral m0 l ecules In the muscle; AMP is a n a l loSteric a. ti v at0r In t he l
ive r gl u co se is a n al l 0St eric in hi bi tor G l y cogen phosph 0ry
la se also eX istsin a ph. sph 0ry l at ed f0 rm an d a n u nph0 spho ry l
a ted fo rm; with t he phos p ho ryl ate d form b ei ng more act i ve 7 4 Wha
t Ar e Zymogens; and How d0 They.
yC. nt r0l en zy m e Activity 24 The di g e sti ve en zy mes trypsi n an d ch y mot r y psin
re cl ass i c exam p les of regulation by zymogen s. The b l.
0d. l0tti ng pro tein thro m b i n is an other 25 T r y psi n; Chymotr
ypsin; and thromb in are a l.
Pr. te aSes Trypsin c lea ves pe pti de bond s wher e th e r e a re am i no a ci
ds with posi . i ve glycha rged side Chains(Lys and Arg) Chymotryps in

c lea Ves pe ptides a t amino acid s with ar0mati C Si de ch ain s; T
r0mbi n c l eave s t he pro tei n fibrinogen i nto fi.
ri. 26 The zymogen for thr0mbin is c leaved to g i ve the active enz. me t
hrombin T he th r 0mbin then cleave s a S 0lu.
le. 0le cule; f ib ri no g en; into an i nso lu b le m 0 lec u le; fibrin F ibri
is a p rote in th at f orm S part of the b lood c l0 t 27 C h ymotryps i n0gen
Sa n i n active zym o gen I isa C ted u p0n b y try p s i n; wh i Ch c l e a ve
s PePti d es at b asi c resi due S l i ke a rgi ni ne; whe n tr y psi n C l
ea ves b et ween the argi ni ne a nd t h e is0l eucine.

Ch. m0tr Yps i n0gen; b ecom es Semiacti Ve; f or mi ng Thismo le
u1. di g e stS i tself f0r the fo rmi n g t he active ch ymot rypsi n As i t tur ns
out; th e a m i no g r0up o f the iso le uCi ne produc ed b y the firs t c le
avage is n e a r th e active s i te of ch y motry. Si n a n d ne c essary for it
s activit y 28 zymo ge n s a r e of t en S een wit h d igestive e. zym
es that a r e pro duc e d i n one tiss ue a n d use d i n anot her If the enzy me
were acti V e imme di ate ly upon pro du c tion; it w oul d l d d ig e s t o the r
e l pr0teins. ere it would c a use great dama ge By having it produc
ed as a zymo. en it can b e sa fely m a de a nd th en t rans p0rt ed t0 the dige Stiv
e tissue; s u ch as the st0ma.
h0. S ma ll in teSti ne; where it c an t be nbe ac ti vat ed 29 Th is a
llows fO r a m ore ra pi d r e sp o nse when the horm on e is re ed ed T he h
ormone. S a l rea d y synthe Size d a nd u Su al ly j u st re qu i re S brea ki ng o
ne o r two b0 nds to m ake i t act ive; Theh0r m0n e Can b e re lea sed a nd read y
to go m0 de m and 7 5 H 0w D0 Ac tiv e s i te Even ts of an E nzym e Affe c t
t he React i on 30.
Se. i ne and hist idi n e are the two m os t cri tica l amino a C i ds in the a ctive
i te 0 f chymo tr y psi n 31 Th e i niti al ph a se re lea s es t he first prod.

ct. nd i nvOlv e S a n a cy l en zy me i nt
er. edi ate; This st e P is fas te r than th e se cond P ar t where wat er com
es i n t0 th e ac t ive s ite an d br ea ks the e nzym e acy l b0nd 2 I
n the fi rst s te p of t he rea Cti0n the S eri ne hy d roxy l is th e nu cle ophi le
th at atta cks t he substrate pept ide b0nd In th ese co nd s te p; wat
er i s the nucle.
Ph. le t ha t att ack s t h e ac yl e nzyme i n te rme diate 3 His 57 pe rfor
ms er i e S0 f s te ps in v0 lv i n g ge n e ra l ba s c a ta ly sis f0 ll0we d b
y ge ner a l acid c a tal ys is In th e f i rst ph a s e; i t ta ke S a hyd
roge n from ser 195; a c ti ng as a g e ne ra l ba S e This is f0 ll0.

ed. mme di ately b y a n acid Cata lys i s ste P wh e rei t g i V es the hyd
r0. en t 0 th e ami de gr0 up. f t he p ep t ide b. n d tha t i. b.
ea. i ng A simi la r s Ch em e ta k es pla ce in the se c0n d Phase 0 f th.
rea ti0 n 34 The f i rst p h. Se i s f
as e rf
Ors eve ra l reas0ns; Th e seri n ea tPo sition [illegible] i nte rs ec tat th ex
max i s int e rc pt
; Whi

Edbylin ki ngsman

er.ni ts (mo nimers) tosctue n APr Oteinsipo ymErome ab y

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C.3 2Ether d CH2 OCH CH3 the Ful cti onal grou p Sint he Com pOun S fol lo 4 ler ore 8 Cthecon cEpt of vit a lism t d th a t organ co oun sc ould.

n.Yrell-deby livings-ste sa na were bey.ndt her-lnO fia lolatory in vest ig at ions wh lerl -sytthe sis showed. at o rga n compoun ds liking rga ni Co nes dudnot re quire a Vit ali St ex.

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iff ere nal con ols 1 la l d th xue s/k eton es a nd each epo Xi des a re ethers 3 wha. Can Bi O chemistr y ST Ab O.

t.oss ib le r is nsofli fe?9 iti Ssefler an yb e lieve at B h tar ioni Sthei ke yb.

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d US Wou ld be Ne Cessar y tola Vea t lea St Vo lar o Snng ber C el

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he.i Ca reactions ni chm ore ef Cie ntlyth a n Wi thhut a ll ysts 14 Thoo the stopvio lsadvanta ges arespe cdan sp ecificity; the ya isoWorkatcon stanttem Perature o fProduc.

li.tien eat i s ddi ngB-1 10 Wso rre p roduct On cells 6 Wi t. resp ect to codin gR NA tyre pol Ynu Cl eot idsha veh epd d U i ce df rom m o n one. Sin t heabsence of ei the rapr e xis ti ng NAto beco Pi edor a en y met Can alyzet ePro C ess Theo. Servation th at s. Me -xis t in RNA mol ecul es canCat- lyze the i. Own Pro ce ss ing sug est s ar o le for RNA in early sis wit hthi Sd.

al.Ole o RNA m ay have be ent heo r ig i nal i nfo rma ti on a nd car om o lecule i n th e orig in of life? It i S un likely that C.

11.C Oui d ha Vear ise nb a recy to pl a s m Wi t h-Out a p la sma m e mbra ne the Pres en

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de.i ran. Cle us bu tuk a r yoteshave an ucleu s mark ea off fro- the rest of th e ce l t ward o blemembrane (2) Pr oKaryotes have nO Plasm ic Ce ll me mbrane ie uka ryotes hav e l ne xtensi V e inte mal m.

lib.ane s ystem (3) Both kar o tic cells contain no m bra ne bounded rga ne lle s wh ile prokar.

Ot.Ce i ls(no u (4) Euka ryoti c cel s ar e n o rmal y lar ger than those of Pr oka ryot es (5) Pro karyo tes a e-i nsie le e orga nis ms.

S hile eukar yotic cell B-em ultice ll ula r Orga nisms Pro e i s y nthe. is ta kes place on i b os o mes in-the P ro kar yotes a n d e kar yote s s in eu kar yot e s ri bosom es m ay be found at ti ee nuoplasmi reti u lum or oundfreein th e cytoPl-sm i n Proka ry o tes rib o so mes ar e on lY foun d free in the cyto Pl asm

t are the m a instru ct ural feat ure s ofP r oka r y ot ic ce ll s 2 0 i tis u lik e lytha t mito C hond riaw. U ndefoldin bac.e ria T he st ukar otic or gani sm are c o s e d y ad ouble- embrane a la tc teri a o ola vean-nal emb ra ne sys tem The.

it.k c ho-ana ro un ineuka ryoti c e l l a re a bou t th. Sam e s i zeas mos- wh at are the Main s truct ura l features of euka ryot ic ce lls? 2 sectio n 16 Of r t h f unc tion sof the a ra s O. an ani a lce l

1 hi Ch-resh ow n in fi gure b1 l C ab 12 2 ls ses Ection. 1 of o the ruc tio- So fth e part s o f Pl an t ce ll s whic h are shown in fi gure The illo bo- 3 l figure ell an tsPh ot osyn t es i stakes Place i nthe memb ra nes ys tem of ch lor oplasts, which are l ar ge m mbran e nc l Sed o rganel les Inp lot Osynthetica ce re the area tefs on Sof the plas ma memb.

an in to the inte rio r ce ll B-ll echlorophor eS wi ch a re thes it Sof Pho to Syn thesi S 2 l N cl ei mito C ho n ri a n hlO.

OP.asts areboll ndedbya dou ble 25 N u cle i mi tochon dri a an chlor oPl asts lcon tain o ndi nmit och Ndri aa di ch lo ro las tsdi f fer s fr om tha tin the 26 Mit OC no ndria c ry out ahi h Pe ne ig ceof th eoxidation en er gy fe el s is reactio n sof the ce ll th e ar et hePrima ry site s of ATP th e o is a p r at tsis in t O iydi ni n in g Carbohydrates to r o g t i nsa d i ne xport in sst ce

ty aCid, fer Are 8 6 5 thi S i Pi ds a ce ra mi de which is o- eki no rs Phin gli pid 9 S Phin go lipi d SC ntain mi de ho nstis do r otein S thoth c alhave.

Yd.0 Phob i ca Nd yd r Ophili C

Pa. ts and both can Occur i nce ll mem bra n es Whe t he ir funct ions ar diff eren t 7 An y co mbi na tion of a tta cid s Sf ss ibleni ss telo i B-sc onta in a c haracte risti c-use d in gstr ic tu e Whic hot er li pi- ds do t 9 wax is ar e este rs of l on g Ch ain carbox y lic, d Sa nd lo ng- Cha i n alcohols t h ey e tat ob r ou nds Pr Ot ecti.

eC.a ti n s 10 -PhOs Pho lipi ds are m ore hydrophi ic t an ch oie ster ol then phoPhate g r ou pis ch arge d an d the the ch ea l c oho ls ch a r g edfro B-apt he se groups n e ctre.

di. With water Cho l ester o l is So n iya si n gl e P O lar group a nd – ll t he ways i s l r a cc oating sa r rie rth ere ve n t s o os of wa ter 13 these u ra cela y x keeps prod uc e fre sh b y preve nti lis.

SS. Fla te r l 4 Cho l este ro is not Very Wa te r So lu b le bu t it i s a s goo d nat ur al de te rgent s which is act ua l ly pa rt of the ri n sth a tt ra sPo rt de l.

SS.olu b l e fatsthr ough th eb loo d 15 The c i ti n in the egs yolks e ry e sas a n d ll b ig a enb. fo r ln d ci b lave sic ces t ri p i a s ln fe but te r (Fr et e cti n g ycero l s a ret eal n d in th eves i c le -and also tfor mas e mulsifie 1 ot he fe m ov al o f t eo ils al so remove s te ng a ty.

al.i is nay a e son t her ather s the y ll usters ne r ate be for e the, ras C ane s 3 what is th e v a ture o f bi o logica l mem ranes? 17 Tr. a Cl ycerol s a r e p ot-oun d i n alin a lm e mbranes l ks tat ene ts C-) an d (D are co ns i ste n twi th wi ta tis kn own a ou t me mbrane s t ructure fe bi nd ing the be ke l lip i d s and pr oteins is tat e en t C J loc Cu rsi nsom a fe Or i eoti rs hu it s tow i desp re ad in t h e ir way fic li t ein Su e inth eli pi bi layer is rat h ert hanbeing s an d wi chebe t ween the sta tement b) Bu t a emp rie cr us teated be fo und i nthe outer li pidbila yer s tate men t (b) 19 The pub lic.

Sa. tine d t h di de a or Pol ylinsat urte d fatts she th e fu ll te m C On figura tions ave S a mo e r a ga.

aile c ons ist ency t ee thoa the v er C fer n sta le ri s ea ft othe Ext en tto hi- hs u C h plauet s i ni cs a t urate.

fats 20 partiallyhydr ognated veget a b le oil s ave he f sir

d C. S is te r yform a N fr oou s Su iiesa ll e flan a ri l e a a c o m p n s Fo s i n 2 1 l any o f t he bu i e n d sal vave be e fa tura tea l c r i Co co nt ain s a r t a i B

Yh.d io o t e n d v e e a a b e i s 22 The Fe l s i S- ta rt ai s B- seass c i t e d- t h d j e t s i o i ns a t u rated- t t Y a i d S 23 T her ansitione mpe ra t ure j S i O.

er. fa B-i pi dbilay e r W i t h Os t i yu n ga t u ra te d fatty acids C o m p a r e at io n with a h i g he r Ce nta ge o f s atu rat ed f atty aci dsS. 1 Fe B-dy ll bro d-sord ered t a i ls T heli c a ye r with h e u n s tu ra t e a t t y a ci dsS. l Fe B-dy ll broad-sor d erea t a B- th e Or i t ha hi gh p ro cent age o f t he sa tl ron s h u ci e ophi ero fth e fl i a i n C e p hi l ic.

tt.Ck l t h e f l o r m s a n C y e n z y m t i n t e r m e d i a t e In t h e e c o n d t a se water i s than u c e o h e a n d i t a 's t i n e fo- wat e r t l i f r

use b th e ri sht s P o t t o re fr o m it s n u c le o phi l i c.

tt.Ck l t i s al so n o t a s s t r o n g a n u c l e o p h il e as th e Se r in e The re fore i t i s l o n e rfo r wate r t o r e f o r m i t s l i- C i e o p h il i a tt a ta d br o kt h ea c y i e n z y m e i n t e r m e d i a t e f i n g th a t k e s l o r s e f i r s t o t r a t e i t l s h i s 7 e x i s t s i n b o t h t h e.

r0. O f a t e r a a n d u n p r o t o l a t e d f o r m a n d i n s t h e c h y l o t r y p s i n r e a c t i o n i t s p r o t o n a t e d l o m a k e s t h i s m o s i b l e i n t h e p h y s i o l o g i c a l p h r a n g e 3 6 l i n s t e a d o f a p h e n y l a l a n i n e l l e l o c i t y c s i l l i.

a r. O t h e S u b s t r a t e s o f c h y m o t r y p s i n l i s e a n i t r o g e n c o n t a i n i n g h a s i d e p h i l i.

r t. t h e i s s u b s t r a t e s o f t h e s i r i 7 6 w h a t t y p e s o f c h e m i c a l r e a c t i o n s a r e n o r m a l l y c a t a l y z e d 3 7 T h e y a t a s t e l i s a c i d a s e l e c t r o n a i r a l c e P t o r s a n d c a t a k e p a r t i n e n z y l e c.

ta. s i s m e c h a n i s m e n z y m e s i s a f a i l t h e c h a l l e n g e s o f a l c l i c a r i s t a r c c a t a l y s i s r e a c t i o n s t h e s a l e a s t h o s e t h a t o c c u r w i t h c h e m i s t r y 3 9 o r e r a t i n c o m p l e x 3 9 c e l l e r a g a c i d c a t a l y s i s t h e p a r t i n e n z y m e l e c t r i c a n a r o p h i l i c.

d0. O t h e r m o l e c u l e s o n a t e s h a v e t o s e n i o r t o a n d t h e r m o e c l u l a r s n s t a l s f o r m o r e c u l l a r f l u c e o p h i l i c s u b s t i t u t i o n t h e u s i m o l e c u l a r t i m e a n s t a t o t h e y s f i r s t - o r d e r k i n e t i c s f t h e r e a c t i o n s i x z 4 0 t h i s r e a c t i o n t h e r a t e i s a e p e n t o n t h e s e q u e n c e i n g t h e b r e a k d o w n o f R X s h 2 s t a t u s f o r i n c l e a r l y e o p h i l i c s u b s t i t u t i o n t h i s h a p p e n s i n t h e s a m e r e a c t i o n s t h e m e t r e a c t i o n b e f o r e t h e a k s o w a n t h u s t h e c o r r e c t a t i o n o f t h e k i n e t i c s r a p h o c a l l e d a n t h e r a t e a s.

Y S. e c o n d o r d e r 4 1 T h e s u p e r e a c t i o n a d a t o m s o f s t e r e o s p e c i f i c i t y t h e x s o l p l e a v e s e r t h e t e m e n t i n g t h e o p h i l e t h i s m e a n s t h e a r t h e r l e c e l o h i l e e n t e r - t h e f i r e n t s i t e s l e a d i n g t h e r e n t o m e r s a 4 2 t h e S u i t s d o r o p o v e t h a t t h e m e c h a n i s m c o r r e c t b e c a u s e t h e r e s u l t s f r o m a f e n t i x P e r i m e n t s u n c o n t r a d i c t t h e p r o p o s e d m e c h a n i s m i n t h a t e t h e m e c h a n i s m s h o u l d h a v e t o m o d i f i e d i f n o d a t e t e n e x p e r i m e n t a l r e s u l t s 4 7 r a t e s t h.

con ect ion be tween the act ive Site and Transition 43 Ag

00. tra n sitions tate a n d s u e v o l l d a v e t o a v e a t e p h e r a l c a r b o n a t om w e r t h a l l e C a r b o n e r s o u b w a s o r i g i n a l.

f0. n d s i n c e t h e t r a n s i t i o n s t a t e i n v o l v e s a m o n e l l a r y t t e t r a h e d r a l f

m. t w o u l d a l s o h a v e t o h a v e a c y l s u l f o n t h e s a m e c a r b o n s o t h a t t h e r e o l a p s l i f i c i t s p e c i f i c i t y f o r t h e i r c a t a l y s i s t e 4 4 t h e i n d u c e d f i t m o d e l a s s u m e s t h a t t h e e n z y m e a n d s u b s t r a t e m u s t b e a b o v e a n d h a t e e O C O - f o r m t o c a c h o t h e r f i t i n t h e s e t h e r e f i t t i n t h e.

e e t h e e n z y m e a n d s u b s t r a t e b u t e

t W. e n t h e e n z y m e a n d t h e t r a n s i t i o n s t a t e o f t h e s u b s t r a t e o n i t s w a y t o P r o d u c t t r a n s i t i o n s t a t e a n a l o g s W i l l f i t t h e e n z y m e i n t h i s m o d e l A N S W E R S T O P R O B L E M S C h a p t e r A n s w e r s w h a t a r e t h e b a s i c t h e m e s o f t h e s t r u c t u r e ? 1 1 p o l y m e r i s a v e r y l a r g e m o l e c u l e.

he ratio of [HPO4 2-]/[H2PO4-] is 2/1 (pKa of $H_2PO_4^-$ = 7.2), as calculated using the Henderson–Hasselbalch equation.

2 HPO4 is a source of the base form, and H [illegible]

1 must be added to convert one third of the acid form, according to the 2/1 base/acid ratio weight.

0.87 grams of K2HPO4 (0.005 moles; based on a formula weight of 174 grams/mole) dissolved in a small quantity of distilled water; add 16.7 mL of 1 M HCl (gives 1/30 of 0.5 moles of hydrogen ion), which converts 1/3 of the 0.05 moles of HPO4 2- to H2PO4-, and dilute the resulting mixture to one liter. [illegible] 27 [illegible] 2/1 ratio of the base form.

Oacid form is still

needed because the pH of the buffer is the same in both problems. NaH2PO4 is a source of the acid form, and NaOH must be added to convert one third of this to the base form. We should use 6 grams of NaH2PO4 (0.05 moles) based on a formula weight of 120 grams/mole, dissolve in a small quantity of distilled water, add 33.3 mL of 1 M NaOH (gives 2/30 of 0.5 moles of hydroxide ion, which converts 2/3 of the 0.05 moles of H2PO4- to HPO4 2-), and dilute the resulting mixture to one liter. 28 After mixing the buffer solution,

n. 1 00 mL contains 0.75 M acetic acid and 0.25 M sodium acetate. The pKa of acetic acid is 4.86. Use the Henderson–Hasselbalch equation: pH = pKa + log [CH3COO-]/[CH3COOH]; pH = 4.86 + log [CH3COO-]/[CH3COOH]

H = 4.86 + log (0.25 M / 0.75 M) = 5.86 [illegible] 1.12 What is the connection between thermodynamics and life? 44 The ordering of entropy needed to give energy [illegible] lead to higher entropy in the surroundings, increasing the entropy of the universe as a whole. 45 [illegible]

a. tmen talization [illegible] brings components of reactions into proximity with one another. The energy change of the reaction is not affected, but the availability of components allows processes to proceed more readily. 46 DNA would have high [illegible] to pyw it the strands separated. There are two single strands instead of one double strand, and the single strands have more [illegible]

information al mobility. 47 See the answer to exercise 43: it is still unlikely that ce

1. Scould have a [illegible] cytoplasm, but the question of proximity of reactants is more to the point than the energy change of a given reaction. 48 It would be unlikely that cells of the kind we know would have evolved on a gas.

a. The lack of solids and liquids on which a [illegible] ate s could form would make a large difference. 49 The available materials, if different from those that would have been found on earth, and conditions of temperature and pressure, are very different. 50 [illegible] because of conditions more like those near the 51 A number of energetically favorable interactions drive the process of protein folding, ultimately increasing the entropy of the universe. 5 [illegible]

IP. Photosynthesis is endergonic, requiring light energy from the sun. The complete aerobic oxidation of glucose is exergonic and is a source

of energy for many organisms, including humans. It would be reasonable to expect the two processes to take place differently.

yi. Or [illegible] provide energy for the endergonic one. Chapter 2 Answers 2 1 2 What is a hydrogen bond? 2 1 Proteins and nucleic acids have hydrogen bonds as an important part of their structures. 2 Replication of DNA and its transcription to RNA require hydrogen bonding of complementary bases to the DNA template strand. 3 The C–H bond is not sufficiently polar for a partial charge to be distributed across its two ends, and so there are not unshared pairs of electrons that hydrogen bond acceptors need.

Or. 4 Many molecules can form hydrogen bonds. Examples include H2O, CH3OH, NH3. 5 For a bond to be called a hydrogen bond, it must have a hydrogen covalently bonded to O, N, or F. This hydrogen then forms a hydrogen bond with another O, N, or F. 6 In a hydrogen-bonded dimer of acetic acid, the –OH portion of the carboxyl group on one molecule is hydrogen bonded to the C=O portion of the carboxyl group on the other molecule, 2 and vice versa. 7 Glucose: 1 7 and so [illegible] 8 ribitol 1 5; e a charcoal group can hydrogen bond to water, and the ring oxygen binds to water as well.

ra. Co [illegible] binding more than the corresponding sugars. 8 Hypoventilation decreases the pH of blood (see Box [illegible] 54) 9 A Spirin is electrically neutral at the pH of the stomach and can pass through membranes more easily than in the small intestine, where positively charged ions will bind to nuclei; acids as a result of electrostatic attraction to the negat.

ve. Y charged phosphate 11 The liquid properties of water form hydrogen bonds. Determine the properties of many important biomolecules. Water, cation [illegible] and [illegible] e g [illegible] electronegativity in biochemical reactions. 12 All atoms did not differ in electronegativity, there would be no polar bonds. 13 [illegible]

is. Would drastically affect all reactions that involve functional groups containing oxygen or nitrogen. That is most of them. 2 3 What are acids and bases? 1 3 (CH3)3NH+ (conjugate

ac. d) (CH3)3N (conjugate base) +H3N–CH2–COOH (conjugate acid) +H3N–CH2–COO- (conjugate base) +H3N–CH2–COO- (conjugate acid) H2N–CH2–COO- (conjugate base) -OOC–CH2–COOH (conjugate acid) -OOC–CH2–COO- (conjugate base) -OOC–CH2–COOH (conjugate base) HOOC–CH2–COOH (conjug.

te. C [illegible] 15 (a) The numerical constant equal to the concentration of the products of the dissociation divided by the concentration of the undissociated acid form: ([H+][A-])/[HA] (b) The equality

ti. e or quantitative description of how much acid (HA) dissociates to hydrogen ion [illegible] (c) The property of a molecule that has both a polar region and a nonpolar region. (d) The amount of acid or base that can be added to a buffer before it experiences a sharp pH change. (e) The point in a titration curve where the added acid or base

qu. Is the amount of buffer originally present. (f) The property of a molecule that is readily soluble in water. (16) [illegible] which in turn has to do with its buffering capacity than the third. All three buffers have the same pH since they all have the same relative amounts of the acid and base form.

m 5 It would be more effective to start with the HEPES base. You want a

hence lysosomes contain hydrolytic enzymes; peroxisomes contain catalase needed for the metabolism of peroxides; and glyoxysomes contain enzymes needed by plants for the glyoxy.

at. Cy cle. All these organelles have the appearance of flattened sacs bounded by a single membrane. 1 7 How do we classify organisms: Five kingdoms or three domains? Monera include bacteria (e.g. E. coli) and cyanobacteria. Protista include Euglena.

V. 1Vo x Amoeba, and Paramecium. Fungi include molds and mushrooms. Plantae include ferns, mosses, and oak trees. Animalia include spiders, salmon, rattlesnakes, robins, and dogs. 29 The kingdom Monera consists of prokaryotes; the other four kingdoms consist of eukaryotes. 30 The kingdom Monera is divided into the domains Eubacteria and Archaea on the basis of biochemical differences. The domain Eukarya consists of the other four kingdoms of eukaryotic organisms. 1 8 Is there common ground for all cells? 31 The main advantage is that of having

gc. ompartments (organelles) with specialized functions and the division of labor. Also the advantage is that cells can be much l

a

rg. r With its surface area to volume considerations being critical because of compartmental [illegible] 32 See the discussion of endosymbiotic.

he. ry in Section [illegible] 33 See Exercise 32 T

he. division of labor in cells gives rise to greater efficiency and a larger number of individuals. This in turn allows more opportunity for evolutionary speciation. 1 9 How do cells use energy? 34 Processes that release energy are favored. 1 10 What is the connection et

ee. Energy and Change? 35 The term spontaneous means energetically favored. It does not necessarily mean fast. 1 1 What is the criterion for spontaneity in biochemical [illegible] 36 The system is the nonpolar solute and water, which become more disordered when also

ut. on is formed. Dissolving is positive but comparatively small. The surroundings negative and comparatively large because it is a reflection

ft. en unfavorable enthalpy change for mixing the solution. (H [illegible] 37 Processes (a) and (b) are spontaneous.

Wh. reas processes (c) and (d) are not. The spontaneous processes represent an increase in disorder (increase in the entropy of the universe) and have a negative G° at constant temperature.

ead Pressure, while the opposite is true of the nonspontaneous processes. 38 In a ca

se, the rise in increase in entropy, and the final state has more possible random arrangements than the initial state. 39 Since the equation involves multiplication by T, the value of G is temperature dependent. 40 If one considers entropy to be a measure of dispe

Si. n of energy, then at high temperatures it is logical that molecules would have more possible rearrangements (dissociated molecular [illegible] 41 Assuming the va

1U. 0 fDS is positive, an increase in temperature will in C

ea. e the contribution of the entropic component to the overall energy change. 42 The heat exchange getting colder reflects only the enthalpy component.

ne. to f the total energy change. The entropy change must be higher, enough to offset the enthalpy component and add up to a negative G. 43 Entropy would increase. The rear

mo. e ways that two molecules, ADP and Pi, can be randomized than a single molecule, ATP. 1 3 [illegible] Water Moving (s) The prop

ty. fa molecule that is insoluble in water; (i) [illegible] water (h) The property of a molecule that is not soluble in water. The property of a covalent bond where there is even sharing of electrons and no dipole moments (partial charges). (i) The property of a molecule that is soluble in water. The property of a covalent bond where the electrons are not shared evenly and dipole moments (partial charges) exist. (j)

ne. Periment where acid or base is added step wise to a compound and the pH is measured as a function of the added substance. 2 14 What is pH and what does it have to do with the properties of water? 16 The definition of pH.

S. og [H+] due to the log function, a change in concentration of 10 will lead to a change in pH of 1. The log of 1 is 0. The log of 10 is 1, etc. 17 Blood plasma, pH 7.4 [H+] = 4.0×10-8 M; orange juice, pH 3.5 [H+] = 3.2×10-4 M; human urine, pH 6.2 [H+]

6 3×10-7 M household ammonia, pH 11.5 [H+] = 3.2×10-12 M gastric juice, pH 1.8 [H+] = 1.6×10-2 M saliva, pH 6.5 [H+] = 3.2×10-7 M intracellular fluid (liver), pH 6.9 [H+] = 1.6×10-7 M tomato juice, pH 4.3 [H+] = 5.0×10-5 M grapefruit juice, pH 3.2 [H+] = 6×10-4 M 19. S

a

li. a) pH 6.5 [OH-] = 3.2×10-8 M intracellular fluid (liver), pH 6.9 [OH-] = 7.9×10-8 M tomato juice, pH 4.3 [OH-] = 2.0×10-10 M grapefruit juice, pH 3.2 [OH-] = 1.6×10-11 M 2.6 What are buffers, and why are they important? 20 The pKa of the buffer should be close to the desired buffer pH, and the substance should not interfere.

it. the reaction being studied. 21 The useful pH range of a buffer is one pH unit above and below its pKa. 22 Use the Henderson–Hasselbalch equation.

U

at. on pH = pKa + log ([CH3COO-]/[CH3COOH]) 5 = 4.76 + log ([CH3COO-]/[CH3COOH]); 0.24 = log ([CH3COO-]/[CH3COOH]); inverse log of 0.24 = 1.7 [CH3COO-]/[CH3COOH] 23 Use the Henderson–Hasselbalch equation pH = pKa + log ([CH3COO-]/[CH3COOH]) 4.00 = 4.76 +

log

([CH3COO-]/[CH3COOH]) = 0.76 = log ([CH3COO-]/[CH3COOH]); inverse log of 0.76 = 0.17 [CH3COOH]/[CH3COO-] 24 Use the Henderson–Hasselbalch equation pH = pKa + log ([Tris]

TrisH+. 8.7 = 8.3 + log ([Tris]/[TrisH+]); 0.4 = log ([Tris]/[TrisH+]); [Tris]/[TrisH+] is inverse log of 0.4 = 2.5 TrisH+ 25 Use the Henderson–Hasselbalch equation pH = pKa + log ([HEPES]/[HEPESH+]) 7.9 = 7.55 + log ([HEPES]/[HEPESH+]) 0.35 = log ([HEPES]/[HEPESH+]); [HEPES] = inverse log of 0.35 = 2.12 HEPESH+ 1.26 At pH 7.

g(J Oo2 /o 0₀ 8)pH 7 7035 Fif Stcalcll

1a. et hemoles0 fbuffer tha tY ou have: (we are going to dO Somero undin goff)1 ooml.

11. it er sando, 1 liter of 0.1 M TRIS buffer is 0.1 mol es. Since the buffer is at pH 7.7, we saw in exercise 5 that the amount of TRIS is 0 ... and the amount of TRIS H+ is 0 ... If you then add ... M HCl you will be adding ... moles of H+. This will react as shown: TRIS + H+ → ... until you run out of something which will be the TRIS since it is the limiting reagent. All the TRIS is converted to TRIS H+: ...

es. TRIS: ... we have used up the buffer capacity of the TRIS ... approximately ... liters of solution ... is approximately ... pH ... 236 ...

[illegible] Our reaction thus ... and ... we ... equatio ... asa buffer ... buffer ... buffer ...

a1. hes ... the ... buffer ... of ... acid ... buffer ... pH ... buffer ... would be suitable ...

OWever the best buf

fe. would be ... the ... buffer ... the ... concentration ...

yp. ... reported ... the sum of the two ... the ...

V. ... because ... buffer ... buffer ... equation ... solution ... pH ... base ... acid ... base ... buffer ... buffer ... H ... the first buffer ...

er. ... you might ... the ... sets of ... these ... two ... the ... chemically ... buffer ... values ... the ... acid ... base ...

es. ... the ... Wo ... buffers ...

ez. ...

O

P

... the ... from ... buffer ... whichever ... the ... base ... would ... hydro ... chloric ... acid ... buffer ... pH ... the buffer ... would maintain ...

...

yd ... acids ... the ...

n ...

DO. [redacted]

... buffer ... pH ... buffer ... acid ... the ... solution ...

et ... buffer ... pH ...

2C. ... ratio ... pH ... buffer ...

+1. ...

eq ...

...

Wi. ...

ti. You ... buffer ... HCl ...

01. ...

1b. ... pH ... TRIS ... 3

01. gy i smirs i nalforlSe Ofcompiarati, ello deli in i ti sbe sto tr ytnatmetio dbiUt he notcom, arth ere silts w it hthoS ebta ine dfro ltierolarcos fi tion 36lse etePrtei Ilatgarlla37.

AP. ionisap Otent iai 1 yi nrectio upSrotein, founalimu it iPi eforisi. mama is Ofren con ctent rateaintl, rvoustisslej T hefei sanor all alforman damatorm dir o mt hitteliest, forlplaue sestrilin gthfe, lo uStisue I T hey ave be en fOu natoretralls missib lelcriss, pecie si 3 8 ASeries orelce hal loa tjheslav ebe enroll.

t0.ecaus eab YtheabnormalPri OnproteinIII

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re.to bsh te t TheabnormaI on ehasa

Ni. Cleaseda47 whatthehou the marist fu Ctu reoProte. ns 240leb OthOita inim. sroll p: tothar eolg, lbi nains te con daryStruct ur eisPrifari i y, helb D ift rence.

- Sa t e t r allerti iemog lobin, sanO no ters o xy en biu intothemo, lo binisc 0 Op erative, butnotio operat.

Vetollyo gl Obin 41

I T.eCru Cia ire Si duesale hist i dnesi nnotnP r

0. eins 421 S hisgstie veloforsalizationiSteriaal Hemo.

1. bin si-Qua, ernaryl 4, I The . -ActiOofhemOg, obinisoX-gen, ransportits, isill oldalbi nding curve refle, ts th er alt that i. cani ndea si I ooise ll-tCompaint.

V -Yhis hpressu resandri easeoxy genati -er pre, is ure S th efuncto lo imo blo, in isoxyg in storis : sjaresslo ; j ti e-si isgatur-te dwi thox ygen atlo- Pressures as shownbyit hy per bolic chinding curve 44 IIlhe P- esenceofH +an dCo2, bothofwhichbillot 0-ellogl Obin; theox- en bilain gcapac i tyofhemoglobinaecr-ases I 45 Imcreas en co2- 3mphosphog lycerate -tebindinlof, xy genbyhemogiobin, chem bi est htto flyoglob in: Character- ze dbyaCkorcooperativ it yl23- 35PhOSPhoSi, ce rat Bin dsatthecen te rofthehemo globi nlo ncule: i -fe ase Soo Petit ivity, St abilities the doxyconforma, ionofheemo globin and mdulua, es the binding ofoxy en sithatit a- -ta si l ver eleaseaint recall-rie 46 Ireta Helmb glob i nlbindSoxy se nores trons, ytha radu thrm Ongiobillsee Figure 45 47 I Hist i din e42inalhain ispla- e dhyaselfile iga 4, deoxyse atedie myobinislave a ke rac id Ha Sahig helP ko tunoxig epatedin.

8. Obin I In Othe r words, deo xygenited hemoglo binbils flor estro- glytoh+tha, de Soxgenat ed he moglobinthe in dinsor+Card OfC- 2 othem, globi nravo rsth ethang is fluater, ar s truCtlleut othe deoxygenated formOfhemoglob.

n. 41 TheP rim ar y fla winyourrienai S r cas olmisi sale versal Orthderin itionbypth whi Oh S pH: anbH+ail Ifthe rease Or hindi-

ArhdrO semiOrhyh eliglo bi nwerelecPr im rtactor i nthe bilrefrec bie PHCh ang es would ie t eopo, ieotthogeactin, ll y Ots elved The res p o lseofhemoglobi nto changesinp H sth, cel tal POi nu- lenthePH in cre ases; thehd rogenioforoncentrat- O heC rase s, andV i cele rs a 50 lheC. allseora- i-tidinetha serineillt he, dalinel- les albsei ti ve I ychair e aminoaci, tha tcolludav eintera ctewithB pd Thus, he pt a rere lfers altbr. de Stob reak sobindinisea sie rth anitisi na5 1 er sofSwitsic kitelt rai ta ve SOm ean- Orma ihemoglob i iAth siali ti Ise9 ther. iS i e s sOxyg elbanat- e Oncentrat ionfthe ce box yform ortheabn. rma in hmogoi Ob i li ncrease, ilessoxy genandhb, ilddcau singthecho, erv eqb h ingiffi culti es 153 Inet ahe mogobi n rue Subil, co mbs tiOns22i threpracedlen tofthechainsbytheCai- S Thes Cide lell ttatioare CS-he cigi ntsot ref eris- onizy gou-f, libsasmormalfe taille 6s10b in 31he re lati velx- gen a ffinit i eiatowX, se ntobe lak enbythe fetace Isfr0mth emite m a i H 5 4 Because p of plewith si Cide cel dis sgsea.

e. hron ic alvane, ic S om ecelsiswithfe, al HSA rep, odll cealth 1 FO, elco m e the im p airedo xy gendlive. Ysys te ill 5 51 Thec Ys tal inefromch ange a teCause oxy gen eliveran ndthe ocers i. P, tl ansfomin gthe oxyhen of 10 bi ntoll yhemOglobir ona.

t. r5A nSlers 51 IHowDowtext ractpure pro te insfromC. iis? lbi lndry P oltertelle the msonicator2 ilr. oIneedea tora intai nth estructur, in tes ritorthesuhCeH unfora, ner les, Ao te rat ive jhelwh lalsbettter, ec besei tistole gent le i The tiSsue s lt hasl iver, muttbeS oite noushto usewithn, isie, icel 3 saltin s outisa.

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n. ther s i Aprote inwi thmOre hi shyPo hl fa mi noAcid Son thesur faceWill beenOre solubi eth an olle wi th mOrE hi ydro, lio hico nSonthes urracel 51 Homogenize theliver cel s usin galbotter E ivei h em hOm ogen i zer sp i nthe homog.

na. eat 50000stime nte ltculhoke. Cell sand nu cle i cen, rifu ge esuper natant ati 5,000xs an aco I lect the P e neP lnlthco.

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etween pot i d echains, si ving more po ssible conformatio S I T here ou amtethe ros sibil.

ty, fordati O n ra uctio nrea C ati orsinfolvi ng Lfhydryla ladisu lf ide, rolibs I 451 Theb igi i fe fe re nc twOulidet hc loss ofst Cre osPecificity.

nt. ecotio ima tionofa nyre ptidor protei in. Soltallavedr astic co nsequences forthe ki nds offeactions Of the r Inteil 3 5 arts malPep tides PhS ioi0gical ly ActiVe 0 Xytoc in a d vasoPrecu.

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te. UsdUringlabor and ilt hefa nmaryg lanasd. Ti ngia Ctd tion va- opre ssi Ihas a p len Y mi atine at Osit io nsaline arg in ifeautp- sitionsi. Stilu latesreso rpti On of water byt hek i dneys th iSr a

is. nglb lodd 47 I Th ertique drOm 0 res illtathi onerOrlist sof the ea- inoicj of Witha sheb, illsroll, th eoxidized fO rmC OrlistsOrs ixaminoac. dSan dCa lleeco nsider the here Suiter imi lli lsttwo molec ules O, F auc eds lu tath io neo a dis Si fi debri dge 4 si En- ehani ls a rerent, peptides CYs gins 5 leu cine lle- hair n and Ilec.

F. Methi O lii n cene-tali, whichare natur al occurring in als esic. 49 Innos tCases Iamin oac id sart.

Xi. Ith Cvocta ri Inatur fa lan tini otics and Dlac teriaIceiiWai si 5 6 thd ifr rentsite roch imistry0. thet woPeptide Sie adstoij frer ente- inding wi thatstrcce pterSand totties te etta stetor oricin atte.

it. eraster Ortito the r iCh aptenA is ler sal Ho wdles theSt, uctur to pro teinspe ter mine their fu nction? 1 (a< 2) Cb)c< Obica)c3) I wh en aProtei nis, denaturath theilte ra cti ohstia tet er min ese cloriary iteriary. An danslla ter nary str uctureare, VefcolleD YthePr esen ceo fthe denaturin ga gento, i Ythe Prim ary stru cture reni nsi ntact 13 Titrian doP ortio. SOrartei n do not contai n Strutur aim o tifstiata rerep eate- with. lt hePlotei lsucrisa, eixol ba P ieate asheep blt hee di mension lre, ture-ortheseba rts of.

eP. Ot intre rela tea Fo mpnemol ecule toan othe lit hst the ter- iary iss om ewhat. Famis nomer 42 wh atistthep rim ary struct ure, orprotei ns? wherap rote.

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er. iltst h e frnai th retl a n d im en, or a Is tru cture ort heprotei n ith en qlific at iOn d iSr. Ptsther old ing sica >serile in Sasm ngsi ac hain tha tc inf ifila, Yfera ti veypo la re lmrin len th Cb. Tr yPto phan hasthe lar gest side hai nof amyortic ollnam in Olcidsy and itt en dstore qui lean onpolnare li vinpolhenl b (ol yS ineandlsl lil nelre.

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id. Chain is g0 Sm allas tor itlinga Cesth at Wiln, oraccomlld ate large r Ones 7lWhe naiamin e is r replaceda lis oleicine there isnotenOlls foolinth ena tiveconform, tionforthe lar e rSide chain Orth eis

Oreuciile c Onsequent ly the r eisa greater olls ichansein, he con forIa tionofthe Pr Otei nthati t0 se SaCt iv ty wheress yC i nei ssub stitutedin tUrnOri sO uelucinet repre senCtOrt.

eS. alle side Cha i nleadsito resllt, tiolnet heaCtivec off Clatiolne. ss serconsist, la rseror aninlip lot ti lsa naitat T then P rait, resor 18 The Cni silgate acid base pairi i lac tasab r fer inthe H la n ge m ni 9TrYb av tine lc harg, at phextrelts, alla theroi eC ule stento rep ti eachotherly hemhemol. Culatch arge i sz eb the ami noaci dsd nassresa teno reeti Iy i2 oi Theioni cdissoc iat

io. ractio nsorthe rolows ami noac ids: aspart i aci ov, lile ih istid ine lserine, and ysi ne 21 Thp Ka. Ortheioniat ionofth ethiolgr ou porcys teine is 3 3, Sothisamin otci dCOuidse rveasa buffer inthel sh a nd sfor. SOv erthepHr an ge 9 3 3 thda mi nOgroups 0, dsrataq ingenally Sitheveplav.

iu. Sofd boan d 9 5 ts fe cti vly thes earteasnos si belbuffe rs buttt heyare bot, near the e na Of th e inuff er ra nges 22 I A tpH the.

rb. Xyisro UpisaPro t0 ntieatoa cano xylate the sidechd ia ar, ly, lisst ii imor et halls 0 tor oton at er and lo thamin ogroups are- roton, ated. AtpH 7 D OTthe ca rboxy l gl Uuloa the sidec haine, lbOx ylgr ou pareater otonated oacdno iy the d rate, andbothamin nogroup sare pro tonated At PHI0 botht hecarboxyl gr0 uP and t he side Chai nca rboxyl group a re dep ro to nateddOaC.

rb. Xylate on eof the ami nog roup si sPr ina r, ly a ePfoto nat ed- ndtheOt. er am inogrou Pi sa mi xtureof t he pr oton atedan deprotonate dforms 23 I TheP I erers. OtherormitIh, ch bothcans oxy igroll Psrede proto, atedand otheaminOgro.

#S. rOtonate datPHof 9 of 2 3 The P I erer s to th

eF. Fminwhic hto tica noxys gi llpsared eProtonatedadn othaminogr, ouPsProton ateatPH, 9 2 4 AtPH, reC ha rse ofsUrstretien.

er. ina nh3+Onv al inanut rePro tona teduani di no sroup Onr a si nin, e SiV in ezer onetcharg q TheCha rgedgrpup sat pH 7 let hesidlea es fl IWi thead ditionofth eCarbX, lat e gr oupon t hec ar r in iluC ine siv li. sa n e t char ge of n 25 I BothpePtides; Phcel ll lle rmve, andallir pe cysne lthalea Cars of le la trl hecauseo fthePr0ton, tedame rina laminiGro, p A tPH 7 the pe ptideof the righthsnomet rarse, echas eorthe P rOt onate d Ve tern i lal alli nor ouP and he ion iiZedC, ef nin alcarb xylate hesa tiv echarge theper ti de, nth ereth asanetcha ge ofin at, H7 becausethe s ide chainca r boxy- ates, ouP On hegut amate indititio nt othech. rge sonth te rmi- nlan, Carten a lgro, Os I 2d (a) Y si nebeca.

Se. fth esi de Chaina mi nogroup; (b) ser ine becalse of thera. ko fas ide chainca rb ox y l; (c) Histid ine, because of thepKa ice of ai tu table gr0uP int he sidechai n; (d) Asp ar tate b, ca llse of the Carbox ylg ro uPin th eside Cha in 27 I GlYG ne isthe n ilY.

ed. Sthe has so ra bufe r nlt he aG aUng ene ar theriOri tscarbox ylgr oUp I the usefu l bl fe ranse, Sf Ior h 3 to 3 3 ath el peP t id e bond 28 S ee Fi gur e 29 I Th eresonance Structure.

C0. ib u te tO th e Pla na r pa rtia l d el lt e bv ng 8 m. p 6 d n we Pr e di C t f0 1 ding fr0 m se quence 3 31 Thi s l eve I Of se quence ar ystructure of r otei ns? 1 5 1 share ?

01. b ility and t r eofb i o lo gica l fu nCti ons S tat ic , str uC tural versus. Yn amic , Ca ta lYti c o lo ir heal St eof th ea mid eplane S- sthe y rotatea i ol tu the a le alb o Thealst es are b ot h defin e claszer ow n. nthetion la nes ou l deove r a p p i ts such th a t th eC arbony. grou tor o nec o ntact S te n H, f the o ther 1 7 Ambu l gei- acom mon 0nre pe ti ti veirre sul ari ty foundi n anti par, al lel She ets 1 A m isa li g nm ent occu. Sbe ule is tr and soft he Shee tca tS il Snes id e to ro w out Wara i st Alever.

et. mi S a re s, 0nor flb l y reptid e where the.

ir. Cti on Chan ge S b a tou t s 0 ther e are two. i lls — tho setia tcolta, Pr oli tan d th S et hat no t ls r isure 4 of ortxa mples h 9 T hea le lais str ul y exte n ded an d its hydrog.

nb. ndsa r ep a ra l e i to th e pr0 te in f rib en th e Pleated sh ee

tS. n uctureisal mos tfu lly ex ten ded an d its hydr 0genbond S are perp e ndi Cu lar t.

t h e protei n fi ter 120 r tha al lit t h e ban unit y the mand, b tiec. eak eY ? the and 21 l the geom. tr Y ortie roi n e resid ueis uc nta itd.

eS. o t fi ti n th ea me l ix b u ilted es fit exact l y for a reverse tur n see fis ure 22 G, Yci e is tie o nly resid ue smal le nou g.

t0. ita t cru ia l ro i n si t te hec. 1 as en d ip le h eli x 23 the prin ci Pal. o mmon ent or w 0 li Sheprotei fi ker a tin y hic h slcia. Sic e xampi e of he lica istructu re th e Pr i mi ra l C mm on tor Sil k iS t he protei n fi b r oin whi ch is aci ass ic xampl e of she estruc ture T hest atele.

ti. Some wh a tra nover sim pli fic ation b l iti fundament a lly- a lid 2 w 00l , whic h CO ls is t s lm ery 0r the prot e in kera tin shrink s b eCa use 0 fits he i Cal conf 0.

ma. i 0n l tra nstret h an d then Shrin k Si k consist s i a ret yor hepr, te inf i b roin which hst ef ul lyexte n d s he e t Conf r Ma tio n , with a. les sten d en Cy to S tretch o Sh rink 4 Wha t an Wes ay b 0 u t th e method y na mics of pr ote in s (1) Ba c k b one H b on d s.

in. 0 ivi n gth eC a.

dN. g r 0u ps of th e pe ti dech a i n (2) Side cha in H bo nds inv olving nyposs i b le hydr oge. bond do nor ora c ceptor son the s id ec ha i ns; (3) hydro pho bi c interac ti o ns inv o l ving th e n 0np 0la r gr 0ups on the p rotein; (4) e l e c t rostati c inter a ct i ons invol vi n g ny char ged gr 0ups on t he protein (5) m eta l i s a ti o n i n v 0lvi ng c oor dinatio n b onds betwee n si de cha ins and m eta l ions 2

S. ab i l i Zati o n Or a nion for m ati 0n depe nds on the ener gy fe sara re s of the k in 0 i nteracti o n inv o lve d i t s ma ll b le c ule inter a ctions, th e chain Com.

0n. n t 0 fe n ergy changes is entia l p i C W ith rel ative ly sm all ent r0 Py- han ge S in the case 0 f mo re. ule S is lar ge as pr otei n, then the ro r possible c onform at i o n s make st heentr op i c ar, 0 fl ers y cha- ses much 0 ri m, ortant this is par ticu lar ly tr u e- n heck seof hy dro pho bi c i nter acti. ns 4 5 tha t is the te rtiary st ru Cture of pr ot e in s? 27 see fi sure 4 2 for any drug 0n th at is ar r o t he hei Xs tcr 0n dar st. Ctur 0 is e figure 4 13 for a hydro phe n 0 la nata t i s Partort. r ti ary str ct u re sid eC ha i n hydr 0gen bond

in s 128 S ee figure 4 13 for elect r ostatic inter a C ti ons su h as S ig htese in between. h es id e c hains of i ys i n and as par tate 29 see fi g ure 4 13 for a n example o f a di sulfide b ond 30 see Fi gure 4 13 of 0-a-e.

am. 1 e 0 hydrophob ic bonds 31 A cha p rone is a p rotein that a id S a fo ur er p rot ein in r o, d in s c 0r r ect y a n d e r s i t f r0ma s soci ation w- th. the r prote in s h e fore i th as fac le di t s fi ra 1 M utu reform 32 Confi sl r ation r.

fe. Sto the Positi on fo r u p s d ue t c ov a le n t bond in gs Exam ples i re l u d e c a r d s i sol ers an d op tic al i somers co n form atio n refer sto the posit. 0 f in gr ou ps i n s ea ue t o rota ti on a fo b a sing. e bond s an exam p le is the diff ere nce be twe nth e C lis e and s tag sefed c 0nf. mat, ons of etha ne 33 Fiv ep oss ib le fe a tu res I i tp ossible pro.

ei. COnfi gurati Ons a nd Conform a tions (

1). T hough any 0ne of the a mino a c i d s is po ssi ble at each posi tion on l y 0 f ei s u sed as d ictate d b t.

eS. net i a tcod e s for tha t pr o tein (2) ei the r d or l forms a mino aci d c 0ul d b e u se d a t e a ch po siti on ex ce p t for gly c in e , but only L amino a ci d s ar.

uS. d (3) The p o ti a ls fo r p i sp l a n a r s, th a . on ly cis and trans arrangement S are o b served the tra ns for m is mo re sta bl e a n d is the one u su a ll y fou n d in pr ot ein s (4) the p la n e s a lo ng a nch e m o r e ticall y t a k e o n a ny va lue, ro t a t ions b u t s ome a ngles a re not possi ble b ecau se o f Steri c h in d r a n ce ; a n g les th a t a re Ster i ca ll y a ll owe d m a y not ha ve St a bilizi ng inter a ctio ns su ch a s th o se in the he l i x (5) Th.

pr. i m a ry Str uct ure det er min es not only much o f terti a ry stru ct ur e acco rd in g t o th e s e c o nd a ry for th e gen eti c co de . e l 3 4 Techni ca l ly , C o- l lag ens qu a te pri m ary stru ct ure bec au s e it h a s S m a ll repe at ing p o ly p ep tide ch ai n s H o we ve r th is d is cu ssio n s of g l obu la r pro teins not f ibrous one s l i ke co lla gen many s c i e nt ist s con s i der t he co l la gen tri ple helix t o b e a n exa mple of ter tia r y stru ctu re here 3 4 a n d e l e ctro s ta ti c e lect r o p h o r es i s wi th a d S P a g e the charge and shape differ e n ces of proteins are el i mi nated so. t h a t th e on- ly a p p a r e n t d e te rm ini ng th e m i gr a tion is the size of the p r ot e in 3 5 i s d u e t o th e p r o t e i n a co n s t a n t r a ti o o f 1 4 g S D S p e r g o f pr ot e in th e r a t i o c o n s t a n t a ll th e p ro t ein with the s a me n e gati v e ch ar ge s a n d a l l s i tn t o l a n d o m co i l s h a p e . Thu s , c h arge a n d s h a p e a re el imi n a te d 3 6 in a p o l a c ry l a mide ge l u s e d for s e p a r a tio n c h ro m a t o gr a p hy t he l a r g e r p.

0t. in scan t h a v e l a r 0 u n t h e be ds , there b ha v in g a s h o r te r pa t h t 0 t ra vel a n d el u ti ng a s t e r w ith el ec t r o pho r e s is the p rot ei n s ar e f or ce d to tr a v e l th rou gh th e m a tr ix s o t he y tra v el m o re slo wl y if the y a re l a rge r b ec au s e th e r e i s m o re fr i c tio n 3 7 T he m is 3 7 ? 0 o d a u to n s l 5 1 4 H 0 n o. E d e t e r mi n e the pr im a r y s tru ctu re of a p ro te in 3 8 i the a m in o ac i d a t t h e W i l l s i v e t h e i d en t i t y o f th e N- ter mi n u s in its f irst c y cle s0 a d d s as e p a r a t e x p er im e n t i s n o- n e ce ss a r y 3 9 I t m i g h t t e l l y o u i f t h e p r o te i n wa s p u r e o r i f t h ere w e r e s u b u n i t s.

4 4. T h e a m o u n t of Ed m a n r e a g e n t m u s t e x a c t l y m a t ch t h e a m o u n t o f N- t er mi n al i n th. f i r s t r ea ct i on i f th e r e i s t o o l i tt l e Ed m a n r e a g e n t

a ta l r ea d y h a s th e a m i d e . C o n f o r m at io n, e i Ps 0 i the, r o t e i n e f f- c i e n c y r a ti o is i n a n ar bi t rar y m e a s u r e m e n t o f t h e ss.

n t. a l a m i n o a c i d c o n t e n t o r a s i v e n t y p e o f p r o t e i n 1 2 E g g s . a v e t h e h i g h e s t p e r 4 3 T h e a m i n o a c i d s t h a t i s t h e c o n s u l t t h e f i n e d i t . b e c a u s e t h e c o n t e n t i s t h e s i z e t h e, i n s u f f i c i e n t q u a n t i t i e s 4 4 R . a s o n s f o r r e c r e a t i n g t h e t i c a l l y m o d i f i e d f o o d s i - c l u d e i n c r e a s i n g t h e i r p r o t e i n c o n t . n t i f i c a t i o n i n g t h e i r s - e l f i f e i n c r e a s i n g t h e i r r e s i s t a n c e t o i n s e c t s o r t h e i r p e s t s / a - d e c r e a s i n g t h e f e a r o f p e s t i c i d e s t o r , w t h e l l 4 , 3 w h a t s t i e s .